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*THE CONDITION, PROSPECTS AND FUTURE EDUCATIONAL DEMANDS OF THE CHEMICAL INDUSTRIES.**

IT has been well said that chemistry is an offspring of the nineteenth century. The closing years of the eighteenth century had some glimpses of the wonders the new science had in store, but it remained for the workers of the first decade of the nineteenth to collaborate the results obtained by their immediate predecessors and develop the new truths which finally established the foundation of the glorious structure, which has now grown so great. During this period human necessities were in every way augmented, and particularly in France, claimed to be the fatherland of our science, human ingenuity was sorely taxed to meet these needs.

The struggle to find ways and means stimulated the energies and increased the zeal of the searchers after truth, and the utilitarian quest, as is always inevitable, brought forth results of interest and value above and beyond the actual needs, furnished data upon which are based the most important and fundamental laws of the science and firmly established many of the most important of our industries. The labors of the chemists of the last decade of the closing century had cleared away the

*Address of the President before the American Chemical Society, Chicago, 1900.

haze which surrounded and covered the truths already developed and opened the way for further promotion of the newly-born science. Lavoisier had led, by the introduction of systematic and accurate observation and record, to the crystallization of what had so far concentrated, and his associates, imbued with his spirit and inspired by his genius, were ready and willing to carry forward what he had so nobly begun.

And so the science was launched. How it has progressed during the century now closing has been told in many ways by many men, and the history seems ever new. New laws and new truths found applications in the industries and increased the material wealth, and the industries in turn furnished the material, the data, the incentive, for much of the additional investigation necessary to the development of the further laws.

The activity of the last decade of the last century has its counterpart in that of the century just closing. If the former century established the foundations, the closing century has furnished a superstructure worthy of the great minds who began the work. And whether we consider the later achievements from the side of abstract science, or from that of the applications of the great laws to the material needs, the glory is equally manifest and the wonder no less profound. Whether we consider argon, and helium, neon, krypton and xenon, and the beautiful researches which led to their discovery, polonium and radium, and their remarkable properties, the Röntgen reactions or the liquefied gases, and the attainment of the almost lowest limit of low temperatures; or the wonderful advances in illumination, the production of high temperatures in the electric furnace, the development of new compounds and forms of matter through the aid of these temperatures, the applications of high electric tensions to the production of new reactions, even those most familiar with them must feel the influence of the mighty strides and look into the future with enthusiastic hope.

The interest manifested in the new science in the old world was quickly extended to the new, and it found most active lodgment here. Students and associates of Black in Scotland, Fothergill in England and of the French chemists of the last quarter of the century in Paris started the work, and the names of Rush, Hutchinson, Woodhouse, McLean, Franklin, Rumford, Priestley, Silliman, Hare, Seybert, Norton, Dana and others, will ever find affectionate memories in the minds of the chemists of America. What these men started has been actively developed by those who followed them, until to-day the science and its applications find more actual workers in our country than are to be found in any other country within the bounds of civilization.

The first half of the century had comparatively few men in the United States who could be classed as working chemists. Chemistry had, it is true, been taught in a way in many of the colleges. But systematic work, as we know it to-day in many of the institutions of learning, was practically unknown. Those who felt the special need of, and had a desire for, such instruction were constrained to seek the facilities in other lands, until generous and at the same time practical men, such as Lawrence, Sheffield, Packer, Pardee and Harrison, with enterprising eyes and prophetic vision, saw the advantages to be derived from the further development of the sciences and provided the means whereby well-furnished laboratories could be opened up, and facilities for the profound study of the science could be made possible. But the industrial needs of the country for more exact knowledge of the natural laws extended beyond private munificence, and the national legislatures early recognized

the importance of the better education of those who must manage the rapidly growing industries. The successful efforts of the late Senator Justin S. Morrill and his associates, in securing the enactment of the law which provided for the establishment in each State of an institution for study of agriculture and the mechanic arts, is well known and will always be gratefully remembered. No less important were the efforts of the late Mr. Hatch of Missouri, who labored so earnestly and eventually so successfully for the establishment of the State agricultural experiment stations. There can be no question that nothing has done more for the promotion of the science of chemistry and its applications than the acts of these great captains of industry and legislation. We shall not forget further the wonderful benefactions of Johns Hopkins, Clark, Case, Rose, Rockefeller, Stanford, Schermerhorn, Havemeyer, Fayerweather, Carnegie and others, who have furnished through splendid munificence the magnificent facilities not only for instruction in the science but for abstract research as well.

The science received splendid impulse and inspiration in the meeting at the grave of Priestley in 1874. It brought the chemists of the country, then comparatively few in number, together and established the bond of good fellowship and scientific sympathy, always so necessary to true progress. The most important outcome of this most important gathering was the organization of our own society. In his address delivered at that meeting Professor Benjamin Silliman named eighty-five chemists who had contributed to the advancement of the science in the United States at that time.

In 1876, the American Chemical Society was organized and during the year enrolled 230 members, of which 190 were professional chemists. The impulse given in Northumberland was effective, the example of a few devoted and public spirited men was followed, and though a period of almost fifteen years was requisite to the ultimate firm establishment of the work of the organization and the integrity of the Society itself, the great aims of its founders to secure the harmonious and thorough organization of all the chemists of the country finally prevailed. The Society has continued to increase in membership and influence, until at the present time thirteen local sections have been established in the various parts of the country, all actively working, and at least six of them holding monthly meetings, during all but the summer months, for such scientific intercourse and discussion as cannot fail to be fruitful in the promotion of the science. The roll of membership now contains about 1,750 names, and while this represents but a small proportion of the working chemists of the country, its growth henceforward must be rapid and the hope of the founders fairly realized.

The *Journal* covers annually nearly one thousand pages of matter fairly representative of the work of American chemists, and it has become necessary, because of increased demands for it, to publish an edition of three thousand copies. Its pages are open to communications on all subjects relating to chemistry and its applications, and it is the hope and expectation that the valuable *Review of American Chemical Research* may be accompanied in the near future by abstracts of papers published in the foreign journals, thus furnishing to all our members information regarding the world's works in chemical science and practise.

The progress made in the applications of chemistry in our country can properly and fully be told only in the results of the census now in progress and in hands which promise results of higher value than have ever before been obtained in such work in

this country. We may congratulate ourselves that it has been entrusted to our past president, Dr. C. E. Munroe, whose tastes and training have so admirably fitted him for the delicate and difficult task submitted to him. But we have in the figures prepared by the Bureau of Statistics of the United States Treasury most significant data regarding the progress made during this closing decade of the closing century. From this source we learn that of products classified as chemicals, drugs and medicines, we imported during the year ending June 30, 1890, to the value of $41,601,978, while for the year ending June 30, 1900, this value had become $52,931.055. Most of the materials represented in these figures entered into consumption in industries, based wholly or in part upon the applications of chemistry. We cannot enter into the details of these statistics, but we may consider with interest and profit a few figures relating to some well known industries, and which are instructive in this connection as showing the variations which have occurred during the decade.

Chemicals imported in 1890 and 1900 respectively:

	1890.	1900.
Caustic soda	$1,470,335	$158,793
Soda ash	3,493,288	665,104
Potash, Chlorate of	238,840	102,337
Soda, " "		93,076
Lime, Chloride of	1,385,080	1,461,858
Glycerine	928,935	2,138,670
Alizarine colors	358,882	771,336
Coal tar colors and dyes	1,787,553	4,792,103
Other coal tar prod		397,780
Milk, Sugar of	46,510	399
Glass	7,411,343	4,038,753

The figures indicate enormous growth of the alkali industry in the United States during the decade and show that in this branch of industry we are entirely independent, as regards supplies, of foreign producers. The figures for glycerine show the possibilities of expansion of another industry, while the almost astounding growth of the importations of alizarine and coal tar products and dyes indicates the necessity for the further development and utilization of our own sources of crude materials of like character and the extension of that already begun. The rapid growth of the establishment of the by-product coke ovens reveals great possibilities in this direction, and it must be disappointing if the characteristic enterprise fails to take advantage of these possibilities.

If the importations of chemical products are interesting and indicate great activity and growth in the industry, the figures for the exportation of similar products are even more significant. We submit figures for the years ending June 30, 1890, and June 30, 1900, respectively, including in the table some data for 1876, the year of the organization of our Society. To have predicted these results in the beginning of the quarter-century would have invited incredulity, but so also would predictions regarding the advances to be made in other lines of human industry. The figures are worthy of careful study.

Values of exports of domestic products of the chemical industries for the years ending June 30, 1876, June 30, 1890, and June 30, 1900, respectively:

	1876.	1890.	1900.
Bark and extracts for tanning	$223,276	$263,754	$376,742
Beeswax		17,927	91,913
Blacking	81,401	238,391	880,049
Candles	229,311	143,073	191,687
Celluloid		39,004	174,264
Acids	50,300	98,084	146,722
Ashes, pot and pearl	75,597	26,211	49,566
Copper, Sulphate of			2,120,745

	1876.	1890.	1900.
Dyes and dyestuffs		717,128	498,056
Lime, Acetate of			776,413
Other chemicals not separately enumerated	2,471,195	2,840,931	5,536,716
Cider		193,283	64,283
Coke		53,586	1,233,921
Coffee and cocoa, ground and prepared, and chocolate		93,735	228,241
Earthen, stone and china ware		175,477	575,823
Fertilizers	922,221	1,618,681	7,218,224
Glass and glass ware	646,954	882,677	1,933,201
Glucose or grape sugar		855,176	3,600,139
Glue	5,798	88,484	225,844
Grease, grease scraps and soap stock		1,506,819	2,944,322
Gunpowder and other explosives	67,887	868,728	1,888,741
India rubber, gutta percha and manufactures of	88,816	1,090,367	2,364,157
Ink, printers' and others		147,057	259,776
Leather		11,175,141	15,363,584
Lime	77,568	134,994	85,854
Cement			163,162
Malt		60,412	215,198
Malt liquors	42,664	654,408	2,137,527
Matches	153,680	62,284	95,316
Naval stores	9,799,923	7,444,446	12,474,194
Oil cake and oil cake meal		7,999,926	16,757,519
Oils, animal	1,975,972	1,686,643	718,997
Oils, mineral, crude	2,220,268	6,744,235	7,364,162
Oils, mineral, refined or manufactured	30,502,312	51,403,089	68,246,949
Oils, vegetable, Corn			1,351,867
" Cotton seed	146,135	5,291,178	14,127,538
" Linseed	23,770	55,036	54,148
" volatile or essential	248,270	223,435	256,597
" all other		102,792	554,295
Paints, pigments and colors	179,882	578,103	1,902,058
Paper and manufactures of	795,176	1,226,686	6,215,559
Paraffin and paraffin wax		2,408,709	8,602,723
Perfumery and cosmetics	375,011	430,151	358,589
Photographic materials		3,891	1,164,465(1899)
Plaster		5,153	35,017(1889)
Lard	22,429,485	33,455,520	41,939,157
Lard compound and substitutes			1,474,464
Oleo and oleomargarine		6,773,522	10,920,400
Butter	1,109,496	4,187,489	3,142,378
Cheese	12,270,083	8,591,042	4,939,255
Milk		303,325	1,133,296
Salt	18,378	29,073	55,833
Soap	684,739	1,109,017	1,773,921
Spermaceti	35,915	116,757	67,125
Spirits, wood			320,306
Spirits, grain (neutral and cologne)		178,257	59,277
" brandy			83,698
" rum		663,039	903,808
" whiskey, bourbon		498,250	764,860
" " rye		137,029	121,241
" all other		165,535	24,921
Starch	524,596	378,115	2,604,362
Sugar and molasses	6,745,771	3,029,413	3,697,366
Tallow	6,734,378	5,242,158	4,398,204
Varnish	54,906	206,483	620,059
Vinegar	6,133	10,520	12,583
Wine	33,483	270,930	62,592
Wood pulp		2,245	458,463
Yeast			36,061
	$102,054,750	$174,803,105	$264,501,771

The figures show grand totals as follows:

For the year 1876	102,054,750
" " " 1890	174,803,105
" " " 1900	264,501,771

In the decennial period just closing the increase in the value of the exports of products of domestic manufacture was therefore about the same as during the preceding fourteen years, and during the quarter-century the growth has been 260 per cent. The growth has been persistent and steady, and indicates what may be expected in the immediate future as well as what is now the condition of development of our chemical industries. This latter condition becomes more manifest when we consider that the products exported constitute but a small proportion of the production, and we may in some degree at least anticipate the results which must be obtained in the pending census investigation.

As a further illustration of the growth of the chemical industries, we may call attention to the condition of the coke industry in the United States in 1880 and 1898 respectively, as illustrated in the following table:

	1880.	1898.
Establishments	186	342
Ovens { built	12,372	48,447
Ovens { building	1,159	1,048
Coal used, net tons	5,237,471	25,249,570
Coke produced, net tons	3,338,300	16,047,299
Total value of coke at ovens	$6,631,267	$25,586,699
Value of coke at ovens, per net ton	$1.99	$1.594
Yield of coal in coke, per cent	63.0	63.6

If we consider that in the recovery ovens, which are fast taking the place of the older and less rational types, this coal should yield 3.38 per cent. of tar, .34 per cent. its weight of ammonia and 8.17 per cent. of gas liquor, all of them bases of most important chemical industries, the figures are significant.

Equally interesting must be the information to be furnished regarding the capital represented in the chemical industries in this country. At the present time, we are able to judge of this to a minor extent from the reported capitalizations of the recently organized companies constituting combinations of preexisting companies. It is true that in these cases the capital represents in a very considerable measure what is known as good will, franchises, etc., but it nevertheless represents earning power and the the average market value corresponds very closely with par value. Taking only those organizations devoted to the chemical manufactures exclusive of the gas and metallurgical and explosive industries, we find that the capitalization as reported in the stock lists amounts to the enormous value of about $1,500,000,000, and this takes no account of many of the incorporated industries not specially reported, nor the industries not incorporated and yet active. It does not include the recently developed electrolytic industries, in which the cash capital actually invested, as we learn from competent authority, amounts to more than $1,500,000. The newly-established by-product coke industry is so rapidly developing and is absorbing capital with wonderful rapidity, while the comparatively new beet root sugar industry has already developed to such an extent as to involve capitalization of nearly $100,000,000 and to develop the establishment of manufacturing plants of magnitude beyond the imagination of foreign manufacturers in the same line a few years ago. Yet this is a general characteristic of the modern chemical industries of the United States, and it is interesting to note that much of the development has been effected empirically and by men comparatively little versed in the principles and laws of the science upon which they are based. The industries have had the aid of but few educated chemists. Happily this condition is rapidly changing. Rational

work is coming to be recognized and the demand for well-trained chemists is increasing. We cannot yet boast with the Germans that single works employ more than one hundred thoroughly educated chemists, yet inquiry shows that many of the important works have corps of chemists numbering from ten to fifty, while very many more have smaller numbers. The same inquiry affords some clue to the number of chemists actually at work in this country. If we compare the list of members of the American Chemical Society, we find that more than two-thirds are engaged in technical work. Furthermore, of the few chemists reported in the inquiry just referred to, scarcely one-third are members of the Society. A fair estimate based upon such data leads to the conclusion that more than five thousand chemists are actually at work in the United States and that eighty per cent. of these are connected with the industries. A study of the lists of the graduates of the educational institutions leads to similar conclusions. Fischer reported as the result of special inquiry made three years ago that in Germany four thousand graduate chemists were employed in the industries and about two hundred in teaching and special investigations.

So then we find that the chemical industries of the United States are growing with enormous rapidity; that they are being concentrated into fewer but larger works; that operations and reactions are being carried out with a magnitude which the earlier chemists would never have predicted; that new methods are being followed; new principles applied, greater accuracy of results demanded both as to quality and yield of the products; that the products now issue from the works in lots of tons at a time of a higher degree of purity and with a greater economy than were possible but a few years ago with lots of a few hundred pounds. For instance, the great sugar refineries each yield from one to two million pounds daily of a product, the purity of which may be considered absolute. The modern beet sugar works have in some cases capacity for treatment of from 1,000 to 3,000 tons of roots daily, and consequently the purification of almost an equal quantity of juice.

And if so great advance has been made during the closing quarter-century and even decade, what shall we say of the possibilities of the future? What is to be the magnitude of the chemical industries of the United States? What shall be the character of the products issuing from them? What will they require of the men who must direct and control them? That is to say, what will be the educational requirements of the American chemical industries of the almost immediate future? These questions are not new to our own country, and their importance has forced itself with powerful intensity upon those engaged in the chemical industries in the old world: it has been the subject of most earnest discussion, particularly in Germany and England, during the past five years at least. Nor has it been in all respects satisfactorily answered. Even within this closing month of the closing century the cable has flashed news of the complaint on the part of the leading statesmen of England that the training of technologists in that country is inadequate to the development necessary to meet foreign competition, and at almost the same time brings news of the inauguration of new institutions for technical education. And in Germany also, the home and starting point of many of the great industries, the demands upon the educational institutions for the better training of technologists are being pressed from every side. It is natural to believe that the time is not far distant when we too shall be called upon to make and meet similar demands. It may be pardonable therefore to discuss briefly what these requirements are likely to be.

First of all, experience shows that those who financially control the great industries fully appreciate the need of improvement in both processes and products are particularly apt in propounding hard questions in connection therewith, and always expect that these questions shall be answered quickly and with the utmost accuracy. Young men who early come to a realization of this fact and prepare themselves by broad and thorough education to meet it are those who will succeed in the industries and ultimately have a controlling influence in their management. And what is to be said here on this subject is directed as much to the students as to those who instruct, for it is not difficult to understand the restrictions placed upon teachers by the students themselves in the struggle to arrange work leading to the training, which many realize to be absolutely essential to meet the requirements of the near future.

For it is beyond question that the most thoroughly educated man is sure to best meet these requirements and become the leader in the industrial struggle of the near future. Dr. Duisberg, the director of the great color works at Elberfield, Germany, rightly fixed the standard when he said that 'above all a general comprehensive education is required. We must have in the industries persevering, energetic men with broad views.' And Dr. Chittenden was right when he said "give a young man a broad knowledge and a thorough conception of the principal laws of physics, mechanics, hydraulics, etc., and he will soon adjust himself to the environment of professional work and eventually rise to a plane far beyond that of the man whose training has been purely technical," and concluding his paper he says, "the rapid development of the sciences and their manifold industrial applications have opened up avenues for new ventures of great magnitude, and there is an increasing demand for young men of broad scientific knowledge and training. He who wishes for the fullest possible measure of success must prepare himself thoroughly for his life work and he can do this in no better way than by acquiring a broad and liberal education."

This important requisite to success could not be better described. Careful general training is conducive to the best thought and the best expression of the results of inquiry. And it is too frequently true that technical men are especially lacking in this particular. Too early specialization must tend to narrowness of view and therefore to limited influence. The general culture work of the preparatory schools, or of the colleges, will always be profitable, whether as preparatory to a specialty or an auxiliary to its prosecution. These principles will apply to all technologists, whether they are chemists or not.

But what shall be the character of the special training of the technical chemist? First of all, we must admit, that this must cover thoroughly and profoundly a study of the science of *chemistry*. Dr. Fittig declares: "Our problem is to study the science as such; to lead the student into the methods of strictly scientific investigation, to put him into position to solve pure scientific problems entirely independent of the question, whether he shall devote his powers to the services of the science itself or apply it to practical questions." He claims that many students take up the study without the scientific instinct. And Erlenmeyer says "a true scientific training should produce ability and susceptibility for all and every use. With a knowledge of the principles and laws of the science, their use becomes easy, they proceed independently." Foerster, discussing the needs of the electrochemists, says "but above all be particular to secure fundamental training in the entire field of chemistry, thus utilizing the principle insisted upon by Liebig, that the best

training for any specialty rests upon the broadest foundation in the whole of scientific chemistry." Dr. Duisberg says further: "in technical chemistry the sharp eye of the scientifically trained man is wanted in order to recognize the individual developments of the reactions in progress, which can be seen only through the accompanying indications." And Richard Meyer truthfully declared: "if our technologists did not properly appreciate the service rendered by men trained in the spirit of Liebig, chemical investigation would miss the stately crowd of auxiliary powers, without which the heights, from which we may now look proudly backward and hopefully forward, could never have been attained." And W. H. Perkin says that "technical education will be of small value unless it is carried out on a very broad and scientific basis."

These views of the leaders in the science of chemistry must find an echo in the mind of every man who has had experience in the industries. In no department of human activity is a thorough knowledge of the fundamental laws so needful, nor can the knowledge of any law be safely neglected if successful work is to prevail. For all the laws apply all the time and few cases will arise in which the more important can be avoided. To suppose that the industries can be carried on in the face of severe competition without such knowledge is to invite failure in every case. Empiricism may succeed in times of plenty, but adversity breeds rationalism and fosters the support it can bring. So then we may make no distinction between inorganic and organic chemistry, analytic and physical chemistry, for each one has its place in the world's work and no one can predict when any one of these branches will be called upon to render material aid.

But whatever may be the department of chemical study, the relation of the science to physics will be keenly felt and the dependence of each upon mathematics as the true foundation will become manifest. For this latter science is just as powerful an aid in the determination of the motions of the atom and molecule in matter as of those of the worlds and constellations in space. And if it cannot be neglected in astronomy, no more can it in chemistry and physics. Indeed, it illustrates the unity of all the sciences, even as it does the correlation of all the forces. Dr. Lorenz set forth the need of all chemists in this particular when he said: "Modern electro chemistry is an exact science and its principles and a knowledge of it rests upon a foundation of mathematics. It is in every way desirable that every electrochemist shall be trained in the higher mathematics and be thoroughly able to utilize both differential and integral calculus." He particularly recommends as a preparation therefor the 'Introduction to the Mathematical Treatment of the Sciences of Nernst and Schonflies' and says: "if the student have an intensive rather than extensive training in mathematics, he may be thrown into the sea of natural science and left to swim." So also Foerster discussing the character of the instruction in electrochemistry in the technical high school, while insisting upon 'thorough fundamental work in organic and inorganic chemistry, physics and physical chemistry' does not fail to include in his plan of work 'the principles of higher mathematics.' Dr. Koerner, discussing the 'Importance of Physical Chemistry to the Industries,' says: "It is most characteristic of it (physical chemistry) that it utilizes the most powerful of all natural aids to scientific investigation, the higher mathematics." And in the curricula of the technical high-schools in Germany we find almost without exception that in the course of chemistry, as well as in engineering, the higher mathematics is taken up and completed before the end of the first part of the year, if not

before the end of the first semester. It thus becomes the ground work of, and preparatory to, all the important work which in those great institutions must follow it.

And finally, the technical chemist of the near future must be trained in the principles and practises of engineering, trained to make and operate the mechanical means for carrying out effectively the chemical reactions of the industries in a large way. For, after all, these reactions differ only in degree from those of the research and preparation laboratories, and if in the latter the students must be trained in making and assembling the forms of apparatus for use in the various operations of pulverizing, separating, roasting and incineration, solution, precipitation, separation of solids and liquids, washing, drying, and care of precipitates and crystals, the production and control of heat, the transfer of solids and liquids, the production and application of vacuum, evaporation and distillation, the conditions of crystallization, etc., in the small way in the laboratories, he must be taught to apply all these and more, in the large way in the works. Indeed, the only difference between the two may be comprised in the terms micro-chemistry and macro-chemistry; chemistry and the operations belonging to chemistry, carried on in a small way with limited or small quantities or volumes; handling solids and liquids in quantities of a few grams or a few cubic centimeters, or liters, on the one hand, or of tons of solids and thousands of gallons of liquid on the other. How, for instance, would the chemist untrained in the principles of engineering proceed in handling materials in quantities involving several tons of solid matters and 30,000 to 50,000 gallons of liquid in a single charge?—a requirement not uncommon in the modern industries and sure to be more common in the future industry. In his day, perhaps, the great Liebig was right and Wöhler was right, and Fittig not far wrong, when they maintained that with a thorough knowledge of the principles and laws of chemistry, all else in the industry involving their application would be easy. It is possible that the genius of the young operator would come to his aid and enable him ultimately to devise means to meet his ends, but time and labor must be saved by training in the methods, whereby such means may be established and a knowledge of means already at hand acquired. The authoress of a late popular work of fiction was right when she said, 'untrained genius is a terrible waste of power,' and though it may not be as applicable here as in an earlier paragraph, she was also right when she said in the same connection, "So many persons think that if they have a spark of genius, they can do without culture; while really it is because they have a spark of genius that they ought to be and are worthy to be cultivated to the highest point." And this applies to the chemists who must operate in a large way and with large masses of matter, either solid or liquid.

In a discussion of this subject in England, where perhaps more than elsewhere in the world the need of engineering capacity on the part of chemists has been most keenly felt, and where, on the other hand, engineering capacity, embodied in such men as Mond, Bell, Muspratt, Weldon, Perkin and Chance, has brought forth such splendid results. Ivan Levinstein, himself a leader in the industry, said: "It must also be palpable that a chemist intended for industrial work, who, along with sound training in chemistry, has also acquired a fair knowledge of chemical engineering, must be better fitted for his work than the man who is only practically acquainted with the handling of china basins, phials or a Liebig's condenser." And in the same discussion Watson Smith endorsed "what had been said as to the importance of teaching

the scientific principles involved in the special construction of apparatus and plant for chemical processes on a large scale."

Dr. Ost, whose connection with both the industries and teaching has been so intimate, says: "Liebig, who had for long years taught technical chemistry in Giessen and, as none other, had promoted the applications of chemistry, could say in 1840 'I know many (those trained in pure science only) who now stand at the head of soda, sulphuric acid, sugar and cyanide works, dyeing and other industries, and without ever having had previously to do with them, were completely entrusted with works processes within the first half-hour, and in the next brought forth a number of most important improvements.' Sixty years ago, this judgment characteristic of the time, this enthusiastic declaration of Liebig, would constitute a dogma, but it is no longer tenable. The chemist graduated from the technical high school is no longer in position to begin his factory experience with introduction of improvements." This, Ost says, is because of the better and more perfect organization of modern works. And Dr. Lorenz of the Zurich Polytechnicum says: "The electrochemist should not be graduated until he has been taught how to use modern methods in very large apparatus. We find in electrochemistry wide difference between the theory and the facts. In the laboratory current yield and greatest economy of electrical energy are often the principal consideration, but in technology corrosion of electrodes or diaphragms is much more expensive than any variation of energy." What an important illustration of a special study of materials of engineering in the preparation for the chemical industry. And what a sensation of sympathy this must arouse in all those who have had to do with the handling of corrosive materials in the very large quantities and volumes, which modern methods involve. How often it happens that success of an important operation is delayed and even made impracticable because of want of knowledge of suitable resistant material for construction of containing vessels or apparatus.

Probably the most important contribution to this subject is that of Mr. Beilby. In his address he says: "I have rarely seen the chemistry of a process lagging behind the engineering; most frequently it is the other way. The chemical reactions involved in the ammonia soda process are simple and easily understood, but it required the genius and practical skill of men like Solvay and Mond to devise apparatus which could establish the manufacture on its present secure basis. What are the elements of which the skill is made up? The scientific basis must be a thorough knowledge of the principles of chemistry, physics, dynamics and mechanics, and added to this there must be a practical acquaintance with the materials of construction and the methods by which they are worked into structures. The designing and construction of apparatus for chemical works is a distinct branch of applied science. It is in this that special skill is required, for works operations are not simply laboratory operations.

"The ideal chemical engineer should be in thorough sympathy with the modes of thought and with the methods of working of both the chemist and the engineer. Just as the professor of engineering teaches how to apply the law of statics, dynamics and kinematics to the design of structures or machines, so should the professor of chemical engineering trace the applications of the laws of chemistry and physics and dynamics in the problems which occur in designing chemical apparatus for works. I am quite satisfied that in the present state of popular opinion the position and work of the technical chemist will not be properly recognized, unless he can associate himself, by his training and practice, with the engineering

side of his calling." Professor Meldola says: "The sooner a chemist is made to realize the enormous practical difference between a laboratory and a factory process, the better it will be for him."

Professor J. A. Reynolds, Director of the Municipal Technical Schools of Manchester, England, says: "English chemists are not engineers and English engineers are not chemists, and hence the enormous difficulty which arises in the endeavor to bring to successful commercial results the fruits of laboratory research." While Mr. David Howard considers that the "influence of mass action, the question of so many pounds of coal per horse power hour and other like things, cannot be dealt with on a small scale, but are all important on a larger scale. We want chemical engineers who can make new roads in chemistry as mechanical engineers do in railways."

It is also important to consider the course of study proposed by Mr. Beilby in his paper for prospective industrial chemists. His large experience in the chemical industry gives him power to speak with authority, and young men who look forward to a successful career in the industry will do well to give it most careful consideration. And even more important, perhaps, are the courses of instruction carried out in the West of Scotland Technical College and in the Municipal Technical School in Manchester, England, and published in the *Journal of the Society of Chemical Industry* during 1899. Students who have had the advantage of these courses must be better fitted than those who have not been similarly favored. Yet we must believe that the courses laid out in the technical high-schools of Germany, and, we are proud to say, in some of the schools of technology in our own country, are in some respects better. A combination of the two classes of course might be made with profit to both the classes of institutions. It is important that the works chemist should be trained in the construction of the special forms of apparatus he needs to use, but they should be accompanied or preceded by the principles and practise of mechanical engineering. The most practical courses, perhaps, are those laid down in many of our own educational institutions for instruction in mining engineering and metallurgy, in which chemistry of the operations is considered in connection with the mechanical details of its applications, and we have advised students desiring to prepare for the chemical industries to pursue these courses in the best institutions first, and to follow them with a year or more of exclusive study of chemistry both pure and applied. If it were possible to add to the courses of chemistry as much of engineering, civil, mechanical and architectural, as is found in some of the metallurgical courses, the ideal would be nearly met. But we can fully sympathize with those teachers who find the time available too limited for such a combination, and appreciate the fact that either the student must come to the professional school with better preliminary training in the preparatory subjects, or the course must be extended beyond the usually provided four years' work. In any case, if the course of engineering could be carried side by side and simultaneously with the course of chemistry, the needs of the prospective technical chemist would be most fully met and the requirements of the future chemical industry most nearly fulfilled. In some of our institutions in which all studies are practically optional, such a course might be arranged and profitably followed, and notwithstanding the longer time which might be involved in its completion, the graduate from it would issue with brighter and better prospects of success in his profession than one less broadly trained. And in the selection of the subjects for such a course, the

plans of study laid down in the technical high-schools of Germany, in the technical schools of England and of our own country, may be profitably followed.

In 1897, we expressed the view which seems thoroughly applicable now and which will perhaps bear repetition here. We said: "It seems, therefore, that the demand of the present time and of the immediate future can be met only by broadly educated men: by men who have been trained, not only in chemistry itself, but in the great principles of physics as well. A good technical chemist must be first of all a thoroughly educated chemist. After that, to attain the highest success in this country, he must be educated in the principles of engineering; the production and applications of heat; the production and applications of electricity; the transmission of power, the movement of liquids; in general, the means whereby the reactions of chemistry may be carried out in a large way We need, therefore, chemical engineers, and these in the nature of the requirements must be broadly and thoroughly educated men. While they must be trained in the work of the research laboratories, which are being organized in connection with many of the great industries, they must likewise be prepared to put into practical operation in a large way the results of the researches they have been called upon to make."

These truths have not changed and if these conditions of education and training are fully met, the progress of our chemical industries must be greatly augmented, the science must, by reaction, be actively advanced and following the experience of our German confrères in the words of Meyer, we may look hopefully forward, and in the near future proudly backward, to accomplishments greater than the world has ever known.

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NEW YORK.

*MAN'S PLACE IN NATURE.**

IN the opening paragraphs of his most memorable contribution to knowledge ('Man's Place in Nature,' 1863), Huxley made mention of certain similarities between the activities of anthropoids and those of men; and, while the burden of the work was devoted to structural homologies, the initial keynote was retouched here and there throughout the discussion. Huxley's classic contribution to anthropology needs no encomium; it was a pioneer's mile-mark of progress, erected under difficulties; and it suffices that all later travelers have found it in the direct way of experiential truth. Yet it is worth while, now and then, to take stock of advances subsequent to, and largely consequent on, the Huxleian declaration.

Since Huxley's pioneer work, a host of investigators have carried forward the study of structural homologies connecting the genus *Homo* with lower genera and orders; and to-day the physical similarities are among the commonplaces of knowledge, whatsoever the background of philosophical opinion concerning cause and sequence. During the last decade or two the investigators themselves, with scarce an exception, have gone one step further, and now include sequence of development from lower to higher forms as among the commonplaces of opinion, whatsoever the background of metaphysical notion as to cause. There the strictly biologic aspect of the question as to man's place in nature may safely be considered to rest; there has been little advance in opinion beyond that of the pioneer in 1863; but the data have been multiplied, and the knowledge and opinion have been diffused widely.

Since Huxley's epoch-marking memoir

*Address of the retiring President of the Anthropological Society of Washington, delivered before the Washington Academy of Sciences and Affiliated Societies, February 26, 1901.

was first published, occasional contributions have been made to knowledge of the activities displayed by various sub-human animals, and during the last quarter of the nineteenth century a science (which has been called the New Ethnology) has been organized to deal with the activities of mankind; yet singularly little has been done in the way of tracing activital homologies between the genus *Homo* and lower genera. It is indeed conventional for sociologists, and customary for comprehensive writers on anthropology, to instance the social habits of mammals and birds, and even of insects and infusoria, as analogous to human society; one naturalist has gone so far as to study various mammals and birds in their activital aspects, thereby opening a most attractive field in science as well as in literature; but investigators have not turned seriously toward the habitual activities displayed by the anthropoids—still less have comparative studies been made of the activities normal to both the higher quadrumana and the lower races of mankind, albeit this is perhaps the most inviting field now open to research. Thus far this line of inquiry grovels in the stage of travelers' tales: the gorilla-hunter tells how the family sire sleeps at the foot of a tree in which mother and young are nested; the naturalist in Liberia incidentally describes the use by monkeys of stick and stone implements, while the Bornean tourist tells of the simian servant who prefers the society of human masters to that of his kin and discriminates among the garments he is permitted to wear; but there is a woeful dearth of critical observation and a lamentable lack of judicious generalization pertaining to this promising meeting-ground of zoology and anthropology. So this aspect, too, of the great question concerning man's place in nature remains nearly as it was left by Huxley; the data are more abundant, and opinion has been both clarified and diffused; yet definite homologies remain practically unfound, if not unsought, and the scattered facts have thrown little light on cause, less on sequence.

Since Huxley's prime, the New Ethnology has arisen; and it has opened a vista of facts and relations which apparently escaped the keen vision of the pioneer in 1863—the vista embracing thought, with all the other psychic factors pertaining to the activities, sub-human as well as human. This vista is perhaps the broadest and most attractive ever opened by science: When Galileo descried the harmonious paths of the planets in a sun-centered system, he raised the minds of men to a new plane; when Newton grasped the idea of gravitation, he gave human thought a new hold on nature; when Darwin discerned the lines of specific development, he wrought a revolution in the world of intellect; but when students still living scanned the lines of activital development and realized that thought itself is bred by the very activities over which it comes later to hold dominion, they opened a new intellectual world—a world at once so novel and so commanding that some of the students themselves are fain to sit at the gate and view the prospect as fleeting phantasm rather than veritable reality. Nor is their hesitation either unprecedented or unpardonable: When the biologists of only one long generation ago unrolled the scroll picturing the origin and perpetuation of species through natural interactions, their interpretation seemed too simple to be true; when the anthropologists of the present generation unrolled a similar scroll picturing the origin of activities (arts, industries, laws, languages, doctrines) through natural interactions and self-developed interrelations—and in this way alone,—their interpretation in turn seemed too simple to be true; and when the anthropologists of the old century's end (and

of this Society) unroll a scroll picturing the origin and development of thought itself through the long chain of interactions between the thinking organism and external nature—and in this way alone,—they foresee that their interpretation must seem too simple to be true—though they find comfort in the teachings of experience that in the long run simple explanations are preferred, that simple doctrines at last prevail, indeed that the progress of knowledge is best measured by its own simplification. But even after full allowance for hesitation and doubt, it must still be said that the opening of the post-Huxleian vista has had much effect; it has widened the view of nature to include the psychical as well as the physical aspects of organisms; it has correspondingly narrowed the range of extra-natural explanations of phenomena; and, specifically, it has revealed a new class of homologies among the races of men and between these and sub-human organisms. So the homologies recognized to-day as defining man's place in nature are of three classes: (1) structural, as wrought out by Huxley; (2) activital, as suggested by Huxley and wrought out by Powell; and (3) mental, or psychic. Expressed otherwise, man's place in nature is now defined, first by what mankind and their kindred *are*, second by what they *do*, and third by what they *think*. And the chief progress of the post-Huxleian epoch, albeit practically confined to *Homo sapiens* in various grades of development, has followed the lines of psychic homologies.

It is just to say that the foundation for modern knowledge of psychic homologies was laid by Tylor in his 'Primitive Culture' (1871), and especially in the seven notable chapters on animism elaborated in successive editions; for he showed that a certain type of philosophy is of world-wide extent, and is, or has been, shared by every race, every known people, whatsoever their diversities of color or condition. This foundation was gradually raised into a definite platform partly by Tylor in later publications, partly by Powell in brief memoirs on 'The Mythology of the North American Indians' (1879) and 'Activital Similarities' (1881), in which it was shown that the interactions between distinct peoples and similar environments frequently produce similar activities, howsoever diverse the peoples themselves; and important additions to the platform were made by Brinton in various contributions summarized in his 'Religions of Primitive Peoples' (1897), in which he showed that the human mind, even in its more complex operations, reflects environment with striking fidelity. True (as recently shown by Boas*), the products of interaction between peoples and environment are in some measure inconsistent and may even at first sight seem contradictory; but, as pointed out on a previous occasion,† the incongruities shrink or disappear when the comparisons are confined to peoples in corresponding degrees of cultural development.

The modern platform for the study of psychic homologies may be defined briefly in terms of a few generalizations, which seem to be consistent with the sum of knowledge concerning the psychic attributes of both human and sub-human organisms, viz.: (1) the mentality of animals is instinctive rather (or more) than ratiocinative, and for each species responds practically alike to like stimuli; (2) the savage mind is shaped largely by instinct, and responds nearly alike to like stimuli; (3) all barbaric minds are measurably similar in their responses to environmental stimuli; (4) civilized minds rise well above instinct, and

*'The Mind of Primitive Man,' SCIENCE, Vol. XIII., 1901, pp. 281-289.

†'Cardinal Principles of Science,' *Proceedings of the Washington Academy of Science*, Vol. II., 1900, p. 11.

work in fairly similar ways under like stimuli; and (5) enlightened minds are essentially ratiocinative, largely independent of instinct, and less uniform in their responses to external stimuli than those of lower culture. The several generalizations are mutually and significantly harmonious; they combine to outline a course of development beginning in the animal realm with organisms adapted to environment through physiologic processes, and ending in that realm of enlightened humanity in which mind molds environment through nature-conquest;* and they measure the gradual mergence of bestial instinct in the brightening intellect of progressive humanity. To, or at least toward, this platform those working anthropologists concerned with the broader aspects of the science have been pressed by accumulating observations and generalizations; yet the platform owes much of its character and most of its strength to the concurrent development of a scientific psychology at the hands of a notable group of experimentalists in psychic phenomena. The several generalizations embodied in the platform have already been summarized as the latest and most comprehensive among the principles of science, *i. e.*, the responsivity of mind;† and by aid of this principle, psychic homologies may be traced between higher culture-grades and lower, and from people to people and tribe to tribe, down to the plane of lowest savagery—where the lines cease for lack of data, leaving the lowly mind in a state even more suggestively akin to that of the subhuman organism than is the lowest human skeleton to that of the highest anthropoids.

Especially within the last decade of the old century, anthropologists have come to recognize a course of development of the esthetic arts—a sort of natural history of esthetics, arising in symbolism, running through conventionism, and maturing in a degree of refined realism found satisfying by civilized and enlightened peoples. Now a significant feature of this development is found in the fact that the initial symbolism is zoic or animistic, putatively if not patently. The esthetic hunger of primitive artists is sated by the carving of totems on reefs or rocks, by the molding of animal effigies, perhaps by the delineation and painting of zoic pictographs; as the artists rise in the scale of culture the zoic designs are partly conventionized (eventually passing into arbitrary alphabets), partly perpetuated in more realistic forms still conceived as fraught with mystical meaning, like the asp of Egyptian sculpture, the dragon of oriental painting, the curiously vestigial unicorn of a modern nation's coat-of-arms, and even the eagles of other national insignia. So, also, when primal man first yields to the charm of music, his songs and accompaniments mimic the rhythmic footfalls of feared or venerated animals, the rustling sounds of animal movements, the inchoate melody of animal voices; when he enters the demesne of drama, his characters are beasts or uncanny monsters tricked out in zoic trappings; and it is only after long stages of development that anthropomorphic motives are introduced, and that the music and drama rise to the plane of realistic representation. In some cases, if not commonly, the germ of esthetic development quickens in painting of face or body, to grow into tattooing; in simplest form the painted devices may serve as

* Cf. 'The Seri Indians,' *Seventeenth Annual Report, Bureau of American Ethnology*, 1898, p. 269.

† "The cardinal principles of science may be reckoned as five: the indestructibility of matter, the contribution chiefly of Chemistry; the persistence of motion, the gift mainly of physics; the development of species, the offering of the biotic sciences; the uniformity of nature, the guerdon of geology and the older sciences; and the responsivity of mind, the joint gift of several sciences, though put in final form by anthropology." *Proceedings of the Washington Academy of Sciences*, Vol. II., 1900, pp. 11–12.

beacon-marks for the identification of kindred (like the face-marks of various animals), as among Seri matrons,* or may symbolize fearsome animals, as among Sioux warriors; but in every well-known case the motive is symbolic expression of zoic attributes. From these germinal efforts of esthetic faculty to that modern stage of art in which the noblest realism and the highest idealism are wedded, the way is long; but every step is marked by the dropping of zoic motives and the substitution of motives springing from human attributes and aspirations.

Within a few years working anthropologists have come to recognize more or less clearly a natural history of industries, comparable with that of arts—a course of development also arising in symbolism, running through instinct-guided conventionism, and maturing in that sublimest product of mentality, invention. It has long been known that barbaric artisans seek omens among birds, borrow lore from beasts, and run to zoic motives in decoration;† it has long been known, too, that savage huntsmen not only imitate the movements of feral animals in the chase and seek to incite their weapons and strengthen their arms by zoic trophies, but even mimic the carnivores' blood-craze in berserker rage at times of battle; and more recently it has been noted that the most primitive implements are of tooth, claw, shell and bone, selected and used as emblems of zoic power. In a typical tribe—the Seri, most primitive of known Amerinds—the pristine implement is a sea-lion tooth, differentiated into arrow, harpoon and fire-stick; the teeth themselves are classed as stones, and natural pebbles are used for tools emblematic of the zoic organs, while the methods of chase and warfare still mimic the habits of local beasts. The lines of human progress from primal savagery to enlightenment may be traced in terms of development of each or all of the great groups of activities; and while all the tracings conform so closely as to inspire confidence in each, no outline is more definite than that represented by the stages of industrial progress—stages best defined in terms of the mind-led activities of which artifacts are normal products. These stages (beginning with that typified by the Seri) are: (1) Zoömimic, in which bestial organs are used as arrows and other implements, to which magical powers are imputed by dominating zootheistic faith; (2) Protolithic, in which naturally formed stones are used for cleavers and other implements, under the sway of mystical faith modified by experience of mechanical chance; (3) Technolithic, in which design-shaped stones are used for knives and other implements in ways revealing the germ of invention; and (4) Metallurgic, in which ores are smelted and used for tools under the influence of invention.* Whether the progress be traced through these stages or otherwise, the way from the simple industries of the prime to the elaborate devices of modernity is long, very long; yet a full half of the steps are marked by the dropping of zoic motives and the substitution of motives expressing man's growing consciousness of power in nature-conquest.

Since Tylor traced primitive culture, and especially since Morgan wrote on 'Ancient Society' (1877), it has been recognized that all known primitive peoples are banded in consanguineal groups, while advanced peoples are bound in larger groups by laws defining proprietary and personal rights;

* The somatic and telic functions of face-painting are discussed in 'The Seri Indians,' op. cit., pp. 167 et seq.

† Even the faith-guided anti-zoic motive of arabesque decoration attests the force of the zoic tendency and the effect required to divert it.

* The stages and transitional sub-stages are set forth in greater detail in 'The Seri Indians,' op. cit., pp. 249–254.

and during the last decade or two working anthropologists have come to recognize the course of development of social organization in its several stages, *i. e.*, the natural history of law. Now it is significant that the most primitive social bond (found alike in America, Africa, Australia and parts of Asia) is that fixed by the ocular blood kinship of maternity, and that the next great stage is defined by paternal relationship; for in both stages the lines seem to be homologous with the instinctive habits of sub-human species, while the earlier the more closely approaches the low plane of brute knowledge —so far as this can be inferred from brute conduct. The researches among the aborigines of America have thrown strong light on the lowly laws of primitive peoples; for it has been ascertained that both savage clans and barbaric gentes are bound not merely by community of blood, but welded into homogeneous units by community of faith in zoic tutelaries—faith so profound, so blent with fear and hope, so impressed by recurrent ceremony from birth to maturity and thence to old age and death, as to dominate every thought and regulate every action. The Amerind tribesmen are grouped by totems (or tutelaries) of Wolf, Badger, Bear, Fox, Deer, Coyote, Eagle, Bluejay, etc.; they call themselves wolves, or badgers, or Bears, or Eagles, and glory in the strength and magical prestige believed to be brought them by their genii; most of them recite traditions of descent from the tutelary animals, or else from fantastic monsters invested with their attributes; and every adequately studied tribe has been found to possess a traditional genesis or sacred cosmogony in which the tutelaries, and perhaps other beasts, are glorified if not deified. The exoteric bond of clan or gens is blood-kinship; but the union is reinforced by an incomparably stronger esoteric bond of animistic belief. The way from beast-clanship to free citizenship is long—so long as to afford the most striking measure of human progress; yet every step of the way is marked by the elimination of zoic concepts and by the substitution of those concepts of higher humanity forced on the genus *Homo* through the ceaseless strife for nature-conquest.

During some decades past, students of aboriginal tongues have been impressed by the failure of primitive folk to discriminate clearly between men and animals in their every-day speech; and this lowly habit forms one of the phenomena which have served (as recently shown by Powell *) as a guide to the natural history of languages. Many Amerind tribes denote themselves by a term connecting animals, either in general or of a particular class, and when pressed to specify are compelled to employ an affix or adjective to distinguish the human kind (often considered inferior) from the rest; some, like the Papago, trace human genealogy through only a few generations, forward or backward, and conceive the lines as beginning and ending in an undifferentiated magma of zoic life designated by a single term; while some groups have progressed so far in the way of human superiority as to dignify themselves by the expressions 'Real Men,' 'True Men,' etc., in contradistinction from alien tribes and other contemptible creatures. The scroll picturing the development of language is expanded about midlength by the addition of the scriptorial branch, representing the growth of graphic expression: and it is quite in accord with the growth-lines of oral expression to find that the earliest essays in ideography are pictures of zoic objects, or objects to which zoic attributes were manifestly imputed. Most of the primal features of modern alphabets have been conventionized beyond recognition, but the hieroglyphs

* 'Philology, or the Science of Activities designed for Expression,' *The American Anthropologist*, Vol. II., 1900, pp. 603–637.

of Mexico and Egypt and the ideographs of China are among the clearer vestiges of primitive standards, while the fancy-wrought constellations of the celestial sphere —birth-mates of pre-Cadmean characters remaining unchanged by reason of remoteness from practical affairs—still conserve the graphic zoolatry in which writing began. The way from lowly language linking men and beasts in word and sign to a discrete graphic vocabulary is long; yet the earlier steps were unquestionably marked by the dropping of instincts shared by brutes and the substitution of humanitarian concepts impressed by ever-widening human associations.

Since Tyler taught the world-wide range of animism in 1871, anthropologists have grouped the myths and faiths of mankind in a series of stages outlining a course of development—a natural history of doctrine —coming up through a slavish and despairing hylozoism, and ascending thence through higher zootheism and broadening worship of nature-powers on successive planes each brighter and more humane than the last. The zoic factors in primitive arts, industries, laws and languages were manifestly made potent in the olden time, as they are to-day among lowly folk, alike by overweening faith and ever-present custom; they were, and still are, kept alive not only by recurrent ceremony and daily taboo and hourly precept, but by tireless study of animal contemporaries whose habits huntsmen must know under pain of hunger; so that much (perhaps most) of the sentient feeling of primal man must have been—as it is to-day among his survivors—of animal contemporaries. In savage life men and their animal associates are compelled to consecrate their best efforts to a study of each other; in affairs of feeling and faith as in matters of immediate utility, the association engenders habits of body maturing in instincts eventually ripening into action-shaping habits of mind; and the strongest mentality is naturally the more deeply influenced—until continued experience of superior faculty awakens consciousness of superior power, stirs the sleeping giant of self-confidence and rends the shackles of zoophobia forever.

> Lo, the poor Indian! whose untutored mind
> Sees *Beasts* in clouds, or hears *them* in the wind:

so a modern Pope would write of the American natives; and so, too, he might write of any and all other aborigines made known through the researches of the last half-century. The upward way from primal beast-faith through concurrent fetichism and shamanism, and thence through mysticism and all manner of occultism, is long and need not now be traced; it suffices that all of the earlier and many of the later steps were marked by the dropping of zoic motives or vestiges, and the substitution of ever nobler motives and imageries.

When the scrolls picturing activital development are brought together—when the natural history of doctrines is outlined over those of languages, laws, industries and arts—the leading lines are found consistent in every essential feature; and all are seen to rise from a mentality both reflecting and approaching that of lower animals (though just how closely may not be measured until the sub-human mind is better understood) toward the higher human plane revealed in science and statecraft. The savage Seri—lowest of American tribesmen —is loathed by Caucasian neighbors as an uncanny beast, and it is a revelation to find that he reciprocates the loathing and glories in the contumely, feeling that it allies him the more closely with venerated consociates like puma and shark, and divides him the more widely from the hated white creatures of unnatural ways; and the sentiment of the Seri is measurably common to all

aborigines of strong individuality. The impressive fact, learned alike through observation of a typical tribe and through analysis of the mental operations of primitive peoples in general, is that the savage stands strikingly close to sub-human species in every aspect of mentality as well as in bodily habits and bodily structures.

Since Huxley's prime the chief advances in anthropology have related to what men *do* and what men *think;* and the progress has been such as to indicate with fairly satisfactory clearness the natural history of human thinking as well as that of human doing. Thereby man's place in nature may be defined more trenchantly than was possible in 1871: (1) As shown by Huxley, the structure of *Homo sapiens* is homologous with that of lower orders, while the morphologic differences between highest anthropoids and lowest men are less than those separating lowest men from highest men; (2) As suggested by Huxley and established by later researches, the activities of *Homo sapiens* are homologous with those of the anthropoids, while the activital range between club-using gorilla and tooth-using savage is far narrower than that separating the zoomimic savage from the engine-using inventor; (3) As shown by the latest researches, the mental workings of *Homo sapiens* are homologous with those of lower animals, while the range from the instinct and budding reason of higher animals to the thinking of lowest man would seem far less than that separating the beast-fearing savage from the scientist or statesman. The resemblances and differences in doing and thinking may not yet be measured in definite units, as are cranial capacities and facial angles (though the recent progress in experimental psychology gives promise of quantitative determinations of general sort at no distant day); yet the relations are hardly less clear and tangible than those customarily measured in inches and ounces and degrees.

So, in the light of the latest researches, man must be placed wholly within the domain of nature, yet above all other organisms at heights varying widely with that highest product and expression of nature, mental power.

W J McGee.

THOMAS BENTON BROOKS.

Thomas Benton Brooks was born June 15, 1836, at Monroe, N. Y. He died November 22, 1900, at his home near Newburg, only a few miles from his birthplace, but during the sixty-four years of his life he had gone far, not only to distant countries but also to fields of experience and thought remote from his early environment. Born to the associations and inheritance of a small farm in a country district, he made his way to a prominent position in engineering and geology by his energy, ability and originality.

His early training and also his later education embodied more practise than theory. The district school, two years (1856–58) at the School of Engineering, Union College and a single course of lectures on geology under Lesley at the University of Pennsylvania (1858–59) cover his formal education, but he seized with eager purpose opportunities to learn in the school of practise. By observation of field methods he fitted himself to pass from axeman to rodman, levelman, transit man and topographer, first on surveys for the Erie Railroad and later on the newly initiated topographical and geological surveys of New Jersey in 1853. In this latter connection he served as axeman to an Austrian who employed a then little-known instrument, a plane table, and Brooks by watching him became so proficient in its use that he succeeded his chief. He was then seventeen. Subsequently, while a student at Union College, he made

extensive surveys in the forested mountainous region west of the Hudson, the Highlands. To this experience he added that of service during one winter with a Coast Survey party in the Gulf of Mexico.

The outbreak of the Civil War found him, at the age of twenty-five, established as a trusted leader among his associates. Enlisting as a private, he was followed by a number of those who had known him as a surveyor, and he was mustered into service as 1st Lieutenant, Company A, New York Volunteer Engineers, September, 1861. He served until the fall of 1864, when he resigned at the request of his parents after the death of his brother, Lieut. J. H. Brooks, in the trenches before Petersburg.

Major Brooks, as he was generally called, although he reached the rank of Brevet Colonel, won conspicuous recognition as a military engineer at the sieges of Fort Pulaski and Fort Wagner. His industry was indefatigable, his engineering talent manifest, his courage, devotion and self-sacrifice unfailing.

After a year with the New Jersey Geological Survey, in August, 1865, Major Brooks accepted a position as vice-president and general manager of the Iron Cliff Mine near Negaunee, in the Marquette iron district, Lake Superior. Therewith his more important work in geologic research may be said to have begun. The geology of the Lake Superior Basin had previously been scanned by Foster, Whitney, Houghton, Logan, Agassiz and others, and the Laurentian, Huronian and Silurian systems had been vaguely distinguished; but the pressing problems of the geology of the iron ores and related formations remained untouched. The difficulties of investigation in that district are even now very great. Forest, windfall and underbrush make the physical labor of exploration severe; drift mantles wide areas, and the relations of the folded, refolded, squeezed and metamorphosed formations are extraordinarily intricate. Settlement of the wilderness, extensive prospecting and mining operations and the development of modern petrographical methods have made a solution of these relations possible, but when Brooks faced them the difficulties were unequaled, the means and methods sadly inadequate. Nevertheless, he attacked them with characteristic energy and originality. He invented methods, he provided means, he spent himself, and he achieved the greatest measure of success then possible. In general geology he contributed important data and conclusions on the great geologic systems and the unconformities which separate them. In theoretical geology he first suggested that secondary deposition might be the genetic condition of the iron ore bodies. But it was in applied geology that he made his chief contribution, one in which he found most satisfaction, and one for which not only Michigan is his debtor, but also the people of the United States. Our country's iron and steel industry, our machine shops, our railway systems, and all the wonderful material conquest of the continent have been greatly promoted by exploitation of Lake Superior iron ores. Brooks took hold of that exploitation in its beginning, and he had a leading part in its development. Simple methods were needed of surveying in the unbroken forest amid widely varying magnetic attractions. Brooks devised the dial compass and taught men to pace distances in the most tangled underbrush. Magnetic surveys were necessary as a means of prospecting. Brooks adapted the dip needle to the capacity and purposes of the prospector. Men wanted practical advice based on scientific principles. Brooks harnessed his practise and his science together, and thus became the most reliable mining engineer, as well as the most useful geologist, in the region.

As the chief authority on the iron-bearing formations of the Upper Peninsula, Brooks was asked in 1869 to take charge of the Economic State Geological Survey of that district, and he accepted on condition that he should be allowed to secure all the private aid possible. The necessity for this provision is apparent when it is understood that during four years the State paid toward the work but $9,000, while he spent $2,000 of his own means and received no pay himself. The results of his work are embodied in Volumes II. and III. of the Michigan State Geological Survey. His reports are direct in style, simple in treatment and extremely practical in substance. They are models of excellence as economic geologic reports. The most original chapters, and those which still possess most practical value, relate to the principles of mine management and of magnetic observations in prospecting for iron ores. For many years the chapters on geology were standards of reference, and they have been replaced only by most elaborate studies, based largely on Brooks' work and carried out with the most refined methods of modern geology. Says Van Hise, Brooks' successor: "Notwithstanding the immense advantage which it has been to have Brooks' work as a foundation, it has taken many years of labor fairly to complete the structural story to which Brooks contributed important chapters. Only those who have labored in the Lake Superior region and who understand its peculiar difficulties can give Brooks credit for the remarkable work he did. His geological work is my ideal of what should be done in a new region of complex geology."

In 1873 Major Brooks' health gave out under the stress of overwork to which he drove himself. He sought relief abroad, and resided in London and Dresden while completing his State reports. He became a Fellow of the Geological Society of London and Corresponding member of the Geological Society of Edinburgh. Returned to this country in 1876, he resided at Monroe and at Newburg, N. Y., and after 1883, during the winters, at Bainbridge, Ga., living the life of a country gentleman and farmer. His interest in science and engineering practice never abated, and he was always ready with wise counsel, even though strength failed him for action.

Major Brooks was characterized by intense energy, which exhausted his physique before he reached middle age; by originality, which combined with common sense made him a most efficient man of affairs; by keen powers of observation and deduction, which he applied untiringly to scientific research; by geniality and affection, generosity, truthfulness and loyalty to principle, which made him beloved and stamped him as a man whose memory will be honored and revered.

Bailey Willis.
U. S. Geological Survey.

SCIENTIFIC BOOKS.

THE APPRECIATION OF NON-EUCLIDEAN GEOMETRY.

Histoire des Mathématiques. Par Jacques Boyer. Paris, Carré et Naud. 1900. 8vo. Pp. xi + 260. Price, 5 francs.

Geometry: Ancient and Modern. By Professor Edwin S. Crawley. *Popular Science Monthly* (January). 1901. Pp. 257–266.

Non-Euclidean Geometry. By Professor Henry Parker Manning. Boston, Ginn and Company. 1901. 8vo. Pp. vi + 95.

The last section of Boyer's attractive book is headed 'Géométrie Euclidienne et Géométries non-Euclidiennes.' He says, p. 240, "The last quarter of the nineteenth century witnessed the building up of interesting theories." The next page continues: "But beyond contradiction the most original researches of this period pertain to the non-Euclidean geometries, and it is by them that we will terminate this incomplete exposition of contemporary science." The brief account which follows (less than five

pages) is certainly stimulating, and is adorned by a full-page portrait of Lobachevski, taken from that given in the Kazan edition of his collected works.

But there is extant another picture of Lobachevski far more impressive, showing him in the plenitude of his powers, which I first saw at Kazan, a daguerreotype from the life, a copy from which you may see as the frontispiece of Engel's monumental 'Nikolaj Iwanowitsch Lobatschefskij.'

As for Boyer's account of what he rates so high, it begins as follows: "From long ago it has been sought to demonstrate the famous axiom laid down twenty centuries ago by Euclid, to wit: through a point only one parallel to a given straight can be drawn."

This of course is not Euclid's postulatum, but rather a paraphrase of what is called (even by Cajori) Playfair's axiom, though Playfair explicitly credits it to Ludlam, namely: "That two straight lines which cut one another can not be both parallel to the same straight line." Boyer continues: "These attempts remained unfruitful. However, at the end of the eighteenth century, an Italian Jesuit, Saccheri, wished to found a geometry resting on a principle different from the celebrated postulate." It was certainly not *the end* of the eighteenth century, for Saccheri died in 1733. Nor did he wish to set up any geometry different from Euclid, since the very title of his book was 'Euclid vindicated from every fleck.'

"Finally," continues Boyer, "at the opening of the nineteenth century, a Russian, Lobachevski, and a Hungarian, John Bolyai, perceived at about the same time the impossibility of this demonstration." In the index, citing to this page, Boyer gives as the dates of the birth and death of John Bolyai 1775–1856, the dates for his father Wolfgang Bolyai (Bolyai Farkas). Lombroso makes this same confusion and identification of father and son, and from it draws testimony for his thesis that great wits to madness are allied.

John Bolyai (Bolyai János) was born December 15, 1802, and died January 27, 1860. At the celebration of his centenary next year in Hungary I hope to be present. Boyer continues: "Their works published independently of each other had without doubt been inspired by the doctrines of the philosopher Kant who, in a passage of his *Critique of the pure reason*, indicated a new consideration of space. For this latter, space existed *a priori*, precedent to all experience, as completely subjective form of our intuition."

In regard to this bold attribution of influence, I may be allowed to say that not a particle of evidence has appeared to show that John Bolyai ever heard of even the existence of Kant. I examined Bolyai's papers, his correspondence, his 'Nachlass', at Maros-Vásárhely, and never found even the name of Kant. As for Lobachevski, he might have had his attention called to Kant by Bronner the professor of physics at Kasan, at one time an admirer of the 'Kritik der reinen Vernunft,' but that Kant influenced him is merest conjecture, and unnecessary, since we sufficiently know the path of his mental on-going. Of Lobachevski's doctrine, Boyer says, p. 242, "He declares at the beginning the following axiom: through a point can be drawn *many parallels* to a given straight."

What Lobachevski does assume is that through a given point can be drawn innumerable distinct straight lines in a plane which will never meet a given straight in that same plane; but of these, only those two are parallel to the given straight which approach it asymptotically.

Continuing, Boyer says of Lobachevski, p. 245, "When he died in 1856 he occupied the position of Rector of the University which he had entered as simple student."

Unfortunately Lobachevski had been deprived of his position of Rector for ten years before he died.

Passing on to Riemann's geometry, Boyer says: "To construct this Geometry, its inventor rejects the postulatum and the first axiom of Euclid: two points determine a straight."

But the postulatum is: "And if a straight cutting two straights makes with them interior angles lying on the same side, which together are less than two right angles, then the two straights intersect if continually produced on the side upon which these angles lie."

In the 'spherical' or Riemannian geometry

here referred to, so far from this being rejected, it actually remains true. In the 'elliptic' or Clifford-Klein geometry its last clause becomes unmeaning, because the straight line does not divide the elliptic plane into two separated regions. Here we cannot distinguish two sides of a straight. Without crossing a given straight we can pass from any one point of the plane to any other point. In this elliptic geometry, the other assumption mentioned by Boyer, that two straight lines cannot meet at more than one point, is retained. Riemann's epoch-making contribution was that the universe while unbounded still may very well be finite.

This gives us the assumption that a straight line has no point at infinity, that is, that every straight line is actually cut by every other straight line coplanar with it.

Now dropping Euclid's implicit, not explicit, assumption that the straight line is infinite, but retaining all his postulates and axioms, especially Postulate 1 (Simon's Euclid, 1901, p. 30), "Let it be granted that one and only one sect can be drawn from any one point to any other point," we have the elliptic geometry.

On p. 245, line 23, is a misprint, 'joints' for 'points.'

Peirce (C. S.), p. 247, is identified with his father in the index, his name being given as Benjamin and his dates as 1809–1880.

Mr. C. S. Peirce is still alive, having an article in the January, 1901, number of the *Popular Science Monthly*, which contains the charming résumé by Professor Crawley entitled, 'Geometry: Ancient and Modern.' Perhaps it could be wished that this article had more definitely emphasized Euclid.

The advertisement of Boyer's 'Histoire' calls mathematics the science of Euclid and Newton.

In writing of 'The Wonderful Cenury,' Alfred Russel Wallace says of all time before the seventeenth century: "Then, going backward, we can find nothing of the first rank except Euclid's wonderful system of geometry, perhaps the most remarkable mental product of the earliest civilizations."

The new departure, the non-Euclidean geometry, is absolutely epoch-making, but fortunately it has intensified admiration for that imperishable model, already in dim antiquity a classic, the immortal *Elements* of Euclid.

Professor Crawley's exposition of the non-Euclidean geometry is exceedingly interesting. But as soon as it gets beyond two dimensions it becomes obscure.

He says, p. 265, "If we proceed beyond the domain of two dimensional geometry we merge the ideas of non-Euclidean and hyper-space."

If we do, we are very apt to blunder. Thus Professor Crawley says, p. 266, "Professor Newcomb has deduced the actual dimensions of the visible universe in terms of the measurement of curvature in the fourth dimension."

This mistake of supposing that a non-Euclidean space requires or needs a space of higher dimensionality has often been publicly corrected.

On page 293 of his 'Nicht-Euklidische Geometrie, I.' Felix Klein puts in pillory the unfortunate title of Newcomb's contribution as follows: "Elementary theorems relating to the geometry of a space of three dimensions and of uniform positive curvature in the fourth dimension. (Die letzten Worte des Titels sind sehr merkwürdig *und deuten auf ein Missverständniss.*)"

After 'we merge the ideas,' Professor Crawley's very next sentence is: "The ordinary triply-extended space of our experience is purely Euclidean." This naïve assertion not only Professor Crawley does not know and cannot prove, but, strangely enough, no one can ever know, no one can ever prove. For Euclidean space the angle-sum of a rectilineal triangle must be exactly two right angles. Such absolutely exact metric results experience can never give.

In connecting a geometry with experience there is involved a process which we find in the theoretical handling of any empirical data, and which therefore should be familiarly intelligible to any scientist. The results of any observations hold good, are valid, always only within definite limits of exactitude and under particular conditions. When we set up the axioms, we put in place of these results statements of absolute precision and generality. In this idealization of the empirical data our addition is at first only restricted in its arbitrariness in

so much as it must seem to approximate, must apparently fit, the supposed facts of experience, and, on the other hand, must introduce no logical contradiction. Thus to-day the ordinary triply-extended space of our experience may be purely Bolyaian, or purely Euclidean, or purely Cliffordian, or purely Riemannian.

In Manning's 'Non-Euclidean Geometry' America has taken a step in advance of all the world in thus putting forth an intended, available class-book for elementary instruction in this fascinating subject.

The book is very gratifying to me, in that the method of treatment that has been taken as the basis of the first chapter is Saccheri's, drawn from my translation, the first ever made, which appeared in the *American Mathematical Monthly*, beginning in June, 1894. My copy of Saccheri is still, so far as I am aware, the only copy on the Western Continent.

It is also matter for congratulation that so many of the further proofs have been taken unchanged from Lobachevski and Bolyai. We rejoice that the world will be rich now in pupils of those who in life had never a disciple.

It perhaps should be noted that though the book says (p. 93), "The Elliptic Geometry was left to be discovered by Riemann," it gives only the simple elliptic, or single elliptic, or Clifford-Klein geometry. It never even mentions the double elliptic or spherical or Riemannian geometry, which Killing maintains was the only form which ever came before Riemann's mind.

GEORGE BRUCE HALSTED.

AUSTIN, TEXAS.

Commercial Organic Analysis. By ALFRED H. ALLEN, F.I.C., F.C.S. Volume II., Part II.; Hydrocarbons, Petroleum, and Coal Tar Products, Asphalt, Phenols, and Creosotes. Third Edition, with revisions and additions by the Author and HENRY LEFFMANN, M.A., M.D. Philadelphia, P. Blakiston's Son and Co. 1900. Pp. viii+322. Price, $3.50.

In the revision of this volume, most of the notes of the second edition have been incorporated in the text, the text condensed to a certain extent, by minor changes, and by omissions, and many valuable additions made. Much matter has been added in regard to the testing of lubricating oils and phenols, and the technology of acetylene. The section on asphalt has been largely increased. The claim of the preface that the nomenclature of the Geneva convention has been applied does not seem justified. Some of the analytical operations are not described in sufficient detail, notably the method for the assay of calcium carbide (page 32). The determination of sulphur in petroleum does not receive the attention it deserves, the most important method—combustion in a current of oxygen or air, and collection of the sulphur dioxide in standard alkali—receiving only passing mention in the section on asphalt. The method for the detection of β-napthol 'suggested' by the American Association of Official Agricultural Chemists was indeed described by the referee in his report, but has not yet been adopted officially by that body. It should be credited rather to Dr. W. D. Bigelow, the referee. It was considered necessary to call attention to these points, but in considering them, the general excellence of the revision should not be lost sight of.

G. S. FRAPS.

L. M. B. C. Memoirs on Typical British Marine-Plants and Animals. Edited by W. A. HERDMAN, D.Sc., F.R.S. V. *Alcyonium* by SYDNEY J. HICKSON, M.A., D.Sc., F.R.S. London, Williams & Norgate. 1901.

A student or amateur zoologist visiting the sea-shore is apt to find the ordinary text-books of zoology somewhat too general to be of much service to him in unraveling the structural details of many of the forms which attract his attention, and the number of forms described in the more special laboratory manuals being necessarily limited, he may find no mention in these of the special organism which interests him. To meet this difficulty the Liverpool Marine Biology Committee has undertaken the publication of a series of memoirs giving detailed descriptions of a number of common animals and plants occurring in the district under investigation by the Committee. The fifth of these memoirs, on *Alcyonium* by Professor Sydney J. Hickson, has just appeared, its predecessor being memoirs on *Ascidia* by Professor Herdman, on *Cardium* by Mr. J. Johnstone, on *Echinus* by Mr. H. C. Chadwick and on *Codium*

by Mr. R. J. H. Gibson and Miss Helen Auld. The editor announces twenty-five other memoirs in course of preparation.

The present little volume, which may be taken as a sample of the series, opens with a brief introduction containing a definition of the order Alcyonaria, and then follow sections on the general appearance of a colony of *Alcyonium digitatum*, its reproduction, the anatomy of the colony, the anatomy of the polyps, the development of the colony and finally its physiology. Three plates containing twenty-four figures complete the little volume, which consists of but twenty-two octavo pages and is sold for the modest sum of eighteenpence.

It is almost needless to say that a description of *Alcyonium* by Professor Hickson is well done, and if the remaining volumes prove as satisfactory as the present one, the editor is to be congratulated upon the initiation of so admirable and useful a series. It would seem that the zoologists of this country might profitably undertake a similar series of memoirs and the idea may be commended to the attention of the officers of the Marine Biological Laboratory. J. P. McM.

SCIENTIFIC JOURNALS AND ARTICLES.

In the January–February number of the *Journal of Geology*, Frank Dawson Adams gives an account of 'The Excursion to the Pyrenees in Connection with the Eighteenth International Geological Congress.' The interest centers largely around certain rocks supposed by Lecroix and some other eminent French geologists to illustrate the transformation of limestone into diorite and of shales into gneiss and granite by emanation accompanying granitic intrusions. Professor Adams does not regard the case as proved and suggests, among other things, chemical analysis as a means of testing the hypothesis. O. C. Farrington contributes a discussion of 'The Structure of Meteorites.' They are treated under three classes, iron, iron-stone and stone meteorites. Structures of the monogenic meteorites are discussed crystallographically those of the polygenic according to their mode of aggregation. In a paper entitled 'The Problem of the Monticuliporoidea,' F. W. Sardeson discusses these much neglected although important organisms of the Paleozoic faunas. Unlike many of the recent writers, he has considered them as corals rather than as bryozoans, and several of the commoner forms are described in such detail as to greatly assist students beginning the investigation of these fossils. 'Valleys of Solution in Northern Arkansas' are discussed by A. H. Purdue. They are described as steep and bilaterally symmetrical, with remarkable straightness, due, no doubt, to their connection with jointing planes.

The Botanical Gazette for February contains the first of two papers by Dr. H. C. Cowles upon 'The Physiographic Ecology of Chicago and Vicinity; a study of the origin, development and classification of the plant societies.' Dr. Cowles gives his views on the classification of plant societies, and proposes a method based on the laws of physiography. The general principles outlined in full have been noted already in Science (Vol. XII., p. 708, Nov. 9, 1900), and are here worked out in connection with the Chicago area. The plant societies are grouped in five genetic series, the first of which, that on rivers, is presented in the first instalment. The paper is illustrated by half-tone reproductions which show the various stages in the development of river-plant societies, from the ravine with its mesophytic slopes, through the xerophytic bluffs stages, and culminating in the mesophytic forest of the flood plain which is regarded as the climax phase of regional development. Mr. John Donnell Smith, publishes his 22nd paper on 'Undescribed Plants from Guatemala and other Central American Republics,' describing about thirty new species from this exceedingly prolific region. Miss Mary H. Smith, of Cornell University, publishes an account of some experiments which would indicate that nitrates are a source of nitrogen for saprophytic fungi. Carlton E. Preston, of Harvard University, publishes a second note on non-sexual propagation in *Opuntia*. Various book reviews, minor notices, notes for students, and news items complete the number.

Torreya is the title of a new monthly journal of botanical notes and news edited for the Torrey Botanical Club by Dr. Marshall A. Howe. A half-tone medallion of Dr. John Torrey, in whose honor the periodical is named, adorns the cover. The object of the journal is to provide a medium for short and semi-popular articles and for reviews, news items, etc., the *Bulletin* of the Club being thus reserved for the longer and more technical papers. It is expected that considerable prominence will be given to notes relative to the teaching of botanical science. The first number of *Torreya* (January) includes the following articles: 'Notes on *Rudbeckia hirta*,' by Dr. N. L. Britton; 'Seedlings of *Arisæma*,' by Dr. D. T. MacDougal; 'Notes on the Genus *Lycopodium*,' by Professor F. E. Lloyd; 'The Summit Flora of King's Mountain and Crowder's Mountain, North Carolina,' by Dr. J. K. Small; 'A simple Dynamometer,' by Dr. H. M. Richards; 'The rare Mosses of Bashbish Falls,' by Mrs. N. L. Britton; and 'Economy in Nature,' by Dr. P. A. Rydberg. The February number contains: 'The Value of Forestry in a Course of Nature Study,' by Miss Elizabeth Carss; 'A new Hygrometer suitable for testing the Action of Stomata,' by Dr. D. T. MacDougal; 'The *Lygodium* at Home,' by Frederick H. Blodgett; 'A new *Senecio* from Pennsylvania,' by Dr. N. L. Britton; and '*Rosellinia ovalis*,' by William A. Riley.

MR. HARRY F. WITHERBY, who has lately made an expedition to the White Nile in search of birds, will commence, in the next issue of *Knowledge*, a series of illustrated articles descriptive of the country, its people, its wild animals and its birds. In the first instalment the author deals with his journey by river and the Desert Railway from Cairo to Khartoum, and gives his impressions of Khartoum and Omdurman.

SOCIETIES AND ACADEMIES.

SECTION OF BIOLOGY OF THE NEW YORK ACADEMY OF SCIENCES.

THE regular monthly meeting for February was held on the 11th, Professor C. L. Bristol presiding. The following program was offered:

D. T. MacDougal: 'The Critical Points in the Relation of Light to Plants.'

A. G. Mayer: 'The Variations of a Newly-arisen Race of Medusa.'

Dr. MacDougal stated that an examination of all the data at hand shows no correspondence among the maxima, minima and optima of intensities of light with regard to the various influences exerted upon the plant by light, and that the current conception of *phototonus* is not based upon well-defined generalizations. Etiolative phenomena of plants are irritable reactions, consisting chiefly in the elongation of organs which would carry the chlorophyll screens and reproductive bodies up into the light. Light is not necessary to the motility of protoplasm, nor for the activity of the motor mechanisms of such plants as *Mimosa*. The condition known as *darkness-rigor* does not exist. Appearances commonly supposed to be due to rigor of darkness are pathological phenomena occasioned by the disintegration of chlorophyll and other substances. Light may exert a direct chemical (disintegrative) effect upon the constructive material of the cell, but it does not retard growth; on the contrary, it accelerates growth in algæ. Evidence that light exercises a paratonic influence upon plants is not at hand, and no observations could be found by the speaker supporting the conclusion that a similar retarding influence of light upon growth occurs among animals. In discussion of Dr. MacDougal's paper, Mr. M. A. Bigelow called attention to some experiments made by him, under the direction of Professor C. B. Davenport, to determine the influence of light upon embryonic development and post-embryonic growth in Amphibia. Light does not retard, but rather accelerates developmental processes, the effective rays being red in embryonic and blue during post-embryonic stages.

Dr. Mayer stated that in 1898 he had discovered a pentamerous Hydromedusa at the Tortugas, Florida, and had named it *Pseudoclytia pentata*. In this form there are five radial canals, five lips, and five gonads 72° apart, instead of four of these various organs at intervals

of 90°, as in other Hydromedusæ. In its anatomy it is related to the genus *Epenthesis*, being indeed very close to *E. folleata*, which also occurs at the Tortugas. It is probably the descendant of some *Epenthesis*, and seems to be a newly-arisen species. No studies have as yet been made by zoologists upon the variations of such forms. The medusa is highly variable. Out of 1,000 individuals 703 are normal radially symmetrical medusæ, with five radial canals and five lips at intervals of 72°, while 297 are abnormal in some respect, having 4, 3, 2, or 6, 7, 8 canals or lips. It is remarkable that fully 50 per cent. of the abnormal individuals are radially-symmetrical. The greater the departure from the normal form the smaller is the ratio of radially-symmetrical individuals. Thus only 11.2 per cent. of the medusæ having five canals are irregular, while 30 to 33 per cent. of those with four or six canals are irregular; in medusæ with seven or three canals 50 per cent. are irregular, while 100 per cent. of those with two or eight canals are so. The lips show a decided tendency to revert to the ancestral number of four, at intervals of 90°, but the canals, on the contrary, incline toward the higher numbers. We have here a medusa which is continually producing radially-symmetrical sports, and is initiating, so to speak, what might become new species were conditions favorable. On comparing the variations of *P. pentata* with those of *E. folleata* or *Eucope*, one is struck with many remarkable family likenesses. This is especially true in the former comparison. The similarity of the variations, the likeness of their abnormalities in these closely-related forms, indicate apparently a race kinship. The abnormal young of *P. pentata* appear to survive fully as well as normal individuals, and abnormal medusæ mature their gonads quite as commonly as the normal forms. The former are not weeded out by natural selection, yet they have not succeeded in establishing new types of medusæ.

In discussion of Dr. Mayer's paper, Dr. MacDougal spoke of a sport of *Populus tremuloides*, discovered by Dr. Britton, in which the irritability to gravity of the leaves had been reversed so that they now pointed downwards. The reversal appeared in the buds. New plants propagated by grafting retained the positive geotropism of the leaves. It was also stated that the 'weeping' varieties of certain trees were usually produced in this way.

Henry E. Crampton,
Secretary.

Section of Anthropology and Psychology of the New York Academy of Sciences.

A regular meeting of the Section was held on February 15th. Dr. D. R. Major reported the results of physical and mental tests on school children of high and of low class standing, the aim of these tests being to discover what relation, if any, exists between class standing and the ability shown in the particular tests used. The tests were as follows: Visual and auditory memory for figures and words, striking out of A's, naming 100 words, copying of figures, weight discrimination, perception of size, sensation-area test as used in the Columbia laboratory, eyesight, age and talkativeness. The tests were made on 150 New York City school children, 68 having high class standing, 82 low. The results of the tests tend to show that the class standing bears a close relation to the ability to pronounce words, to carefulness or accuracy in striking out A's, to memory for words, to eyesight, to age (the average age of the good pupils being less than the average age of the class), and to talkativeness (the good pupils being as a rule talkative). There is apparently little, if any, relation between class standing and the ability shown in the other tests mentioned. The study, however, is not completed and the opinions expressed here are subject to change. In addition to the use made of the standard psychological tests, an attempt is being made to devise tests to determine the presence, nature, and quality or worth of apperceptive activities.

The second paper by Mr. E. A. Spitzka described with special reference to their similarities, the brains of two distinguished physicians, Dr. Edouard Seguin, and his son, Dr. Edward C. Seguin. The most striking similarity discoverable in these brains is the unusual development in the left Insula. This similarity was attributed by the author to heredity, and was

held to be the physical basis for the high type of ability shown by both the Seguins in the use of language. CHARLES H. JUDD,
Secretary.

SECTION OF ASTRONOMY, PHYSICS AND CHEMISTRY OF THE NEW YORK ACADEMY OF SCIENCES

A REGULAR meeting of the Section was held on March 4, 1901. The annual election of officers of the Section was held, Professor William Hallock being elected Chairman and Dr. F. L. Tufts, of Columbia University, Secretary for the ensuing year.

The first paper was by Professor R. S. Woodward and Mr. J. W. Miller, Jr., on 'The Elastic Properties of Helical Springs.' This was part of an investigation now in progress and the details will be published later when the investigation is completed.

Dr. F. L. Tufts then read a paper on 'A Photographic Study of the Air Movements near the Mouth of an Organ Pipe.' In this paper the author described experiments in which he applied the 'method of striæ,' similar to that used by Toepler, C. V. Boys, R. W. Wood and others, to the study of the vibrations within an organ pipe. The pipe used had sides made of plane parallel glass plates. The tongue of air at the mouth of the pipe was made visible by using air mixed with alcohol vapor which changed its optical density. The vibrations and air currents within the pipe were made visible by the introduction into the pipe of small jets of illuminating gas. The intermittent illumination used was the spark between magnesium ribbons from an induction coil. It was found quite easy to adjust the rate of interruption of the coil so as to produce a stroboscopic effect, and thus the movements of the tongue of air in the mouth of the pipe and the vibrations and air currents in the pipe could be readily followed.

The same method was also applied by the author to study the behavior of unignited jets of illuminating gas when acted on by sound waves. The paper was illustrated by a number of photographs of the phenomena observed.

WILLIAM S. DAY,
Secretary.

THE LAS VEGAS SCIENCE CLUB.

THE third meeting of the Science Club was held February 12th. Mrs. Cora W. Hewett exhibited shells of *Pyramidula strigosa* varieties *depressa*, *Cooperi* and *major*, which she had collected between Mora and Peñasco, N. M. It was remarked that, though occurring together, the *depressa* and *Cooperi* forms did not appear to intergrade. Miss Mary Cooper exhibited numerous species of New Mexico Mollusca, including *Ashmunella thomsoniana porteræ* from Manzanares Valley, a new locality. Mr. T. D. A. Cockerell exhibited and discussed a number of shells from a pleistocene deposit at the Arroyo Pecos, Las Vegas. The shells appeared to be all of living species, but he had found in the deposit part of the jaw and a tooth of a species of *Microtus* which, judging from the enamel pattern, was clearly distinct from any species now recognized as living in America. Mr. Cockerell also exhibited specimens of a wax-scale, *Ceroplastes sinensis*, Del Guercio, received from the Agricultural School at Portici, Italy, with the information that it was infesting lemon trees at Chiavari, Italy. It was supposed that the insect reached Italy from China, but it was very close indeed to *C. mexicanus*, Ckll., a species not uncommon in Mexico.

T. D. A. C.

OTTAWA FIELD NATURALISTS' CLUB.

AT the last meeting of the Club held at Ottawa, January 29th, the following papers of special interest to geologists were presented:

Observations on the Crows' Nest Pass. By MR. JAMES MCEVRY, of the Geological Survey of Canada.

Mr. McEvry spoke of the geological structure and economic resources of the Pass and illustrated his paper by means of lantern slides prepared by Mr. J. Keele.

Explorations in Baffin Land. By DR. ROBERT BELL.

This paper gave a graphic *résumé* of the researches carried on by Dr. Bell and his party along the North Shore of Hudson Straits and in the interior of Baffin Land. Numerous lantern slides illustrating the geological struc-

ture and orographic features of the regions traversed accompanied Dr. Bell's paper.

The 'Report of the Geological Section, for 1900–1901,' was then presented by Mr. H. M. Ami, in which were pointed out the nine important discoveries in the Chazy, Trenton, Utica and Lorraine formations in the Paleozoic about Ottawa as well as those in the Pleistocene and marine clays, sands and gravels, etc., of the same district.

H. M. Ami.

SHORTER ARTICLES.

ARSENIC TESTS.

The note concerning arsenic tests on page 313 of the current volume of Science brings to my mind some experiments made while testing for arsenic in glycerol, an account of which is found in the *Journal American Chemical Society* for Nov., 1895. I found the destruction of the organic matter (before applying the Marsh test) by a mixture of sulphuric acid and nitric acid (30 to 1) caused a loss of arsenic in some samples but not in others. In one sample treated with this mixture it was found impossible to detect even added arsenic. My conclusion at the time was "that some at least of the samples contain, or are decomposed into, something capable of holding back arsenic. This leads to the query: What is the effect of the combined glycerol present in the toxicological examination for arsenic? May not the trouble with the glycerol be due to a decomposition product which could also be formed in the supposed case?" I have never had time to investigate this point myself, and as far as I know it has never been discussed in print. May not the trouble with the Marsh test as applied to beer be due to the same cause? I was able to detect arsenic in the above-mentioned case by adding the sample diluted with water directly to the reduction flask.

A very simple, convenient and delicate method for detecting arsenic in glycerol is mentioned by several writers. I am not certain who first applied it, but think it was Ritsert. The glycerol is diluted with an equal volume of water, HCl and zinc added, and a yellow coloration obtained, if arsenic is present by exposing filter paper, moistened with either silver nitrate solution (1 to 1) or saturated mercuric chloride solution to the evolved gas. A twenty-five cc. measuring glass is convenient for carrying out the test, the filter paper moistened with the solution being placed over the mouth. This test carried out with mercuric chloride is not as delicate as the Marsh test, but when silver nitrate is employed it is about five times as delicate. E. Ritsert (*Pharm. Ztg.*, 1888, 715 and 1889, 104, 360 and 625) finds this test to show 0.001 mg. of arsenic in 1 cc. of solution where the Marsh test only shows 0.01 mg. in 1 cc.

G. E. Barton.

Millville, New Jersey,
Feb. 25, 1901.

PRELIMINARY NOTE ON THE EMBRYOGENY OF NELUMBO.

For two years the writer has had *Nelumbo lutea* under observation and has demonstrated among other points those enumerated below. The discoveries, and the conclusions arising from them, are of such importance that publication in advance of the complete memoir seems advisable. They are as follows:

1. The membrane surrounding the plumule has been shown to be, as conjectured by Wigand, a true endosperm arising within the embryo sac.

2. The embryo is genuinely monocotyledonous in development and the conclusions of Mirbel are erroneous. The plumule arises laterally and at first there is but one cotyledon. Later this bifurcates to form the two fleshy bodies which since Mirbel's researches have been generally regarded as separate cotyledons. For the views of Barthélemy, Richard, Clos and others who have altogether denied the cotyledonary nature of the fleshy bodies, there is no foundation in fact.

3. There is no primary root. The first roots are adventitious and spring from the epicotyl.

Nelumbo, both in its anatomy and embryogeny, conforms to the type of the Monocotyledons and, probably with the other Nymphaeaceae, should be classified in the general vicinity of the Alismaceae.

Harold L. Lyon.

The University of Minnesota,
March 14, 1901.

CURRENT NOTES ON PHYSIOGRAPHY.

PHYSIOGRAPHY OF NEW BRUNSWICK.

GANONG continues his 'Notes on the Natural History and Physiography of New Brunswick' (*Bull. Nat. Hist. Soc. New Brunswick*, xix, 1901, 313–340), presenting accounts of the development of several rivers and lakes. The Nepisiguit, for example, is explained as the result of successive captures of portions of three other systems by what is now the lower part of this river. The Negoot lakes, of picturesque outline in a district of primeval forest, are described as resulting from the obstruction of a series of nearly parallel valleys by masses of glacial drift. In the discussion of these problems it is implied that the shores of the Silurian sea are indicated by the present margin of the Silurian strata, that certain existing river courses were determined in pre-Silurian times and that even the valleys of certain rivers and lakes are pre-Silurian; but it is difficult to accept these conclusions on the evidence that is presented. A slight misapprehension as to the meaning of 'monadnock' is indicated in the statement that a hill which rises over the eastern peneplain of Carboniferous strata east of Grand lake is 'not a real monadnock,' for 'it is composed of a ridge of volcanic rocks, and hence remains, not because it is left behind in the general erosion, but because it resists erosion better than the surrounding rock.' It is for such resistant residual mountains and hills that the term monadnock is coming to be generally used.

DRAINAGE CHANGES IN NORWAY.

'THE Sundal Drainage System in central Norway,' by R. L. Barrett (*Bull. Amer. Geogr. Soc.*, xxxii, 1900, 199–219), is an account of a curious series of changes in drainage lines, whereby the upper valleys of the Opdal system that once discharged northeastward into Trondhjem fiord are now discharged northwestward to Sundal fiord. The Opdal system consisted of numerous broadly open valleys with convergent courses and continuously sloping floors. The Sundal, a canyon-like valley, trenches the highlands in which the upper Opdal branches are opened, and receives the waters of several narrow gorges that are eroded in the mature Opdal floors. As a result the lateral stream courses to-day no longer converge towards their trunk, but enter it in a backhanded or barbed fashion;

Sundal system, solid black. Opdal system, outline.

and while the heads of the Opdal system were well enclosed by the highlands, the head of the Sundal system is separated from the head of what remains of the Opdal system only by a flat divide on the mature valley floor. As the gorges and canyons of the Sundal system deepen downstream through the rising valley floors of the dismembered Opdal system, the main Sundal canyon comes to be 1,000 meters deeper than the highest head valleys that it dissects. In explanation of these curious changes, Barrett concludes that normal headward erosion by the Sundal system is of uncertain and probably small value; westward overflow from ice-dammed lakes that occupied the upper Opdal valleys while the trunk was filled by advancing or retreating glaciers is given more importance; and a still greater share of work is attributed to glacial overflows, when great ice-sheets overwhelmed the region and disregarded the divides that had controlled preglacial river drainage. It is pointed out that the Romsdal, next southwest of the Sundal, exhibits a similar barbed relation between its branch and trunk streams, thus suggesting an interesting field of study for a summer month in Norway.

THE ASSAM EARTHQUAKE OF 1897.

A THOROUGH 'Report on the Great [Assam] Earthquake of 12th of June, 1897,' has been made by R. D. Oldham (*Mem. Geol. Surv.*, India, XXIX., 1899. Pp. xxx + 379 + xviii., 41 pl., 3 maps). This earthquake is said not to have

been surpassed for violence and extent by any of which there is historic record. An area of 150,000 square miles was laid in ruins, all means of communication interrupted, the hills rent and cast down in landslips, and the plains fissured and riddled with vents from which sand and water poured out in most astounding quantities, causing floods in rivers, while a surrounding area of 1,750,000 square miles felt an unusual shock. The earthquake wave is estimated to have traveled at the rate of 120 miles a minute. The amplitude of wave motion near the epicenter was probably 14 inches, and the velocity of wave motion was probably 14 feet a second. It is suggested that the shock may have been caused by a slight movement on a thrust plane, thus accounting for the compression indicated by kinks in railways, and by a slight diminution of north-south distances indicated by a revision of former triangulation. Two hill stations seem to have been lifted by about 20 feet over their former altitude. A number of surface faults are described and figured, one of which had a throw of 25 feet and a length of 12 miles, and another a throw of 10 feet and a length of two and one-half miles. The greater fault produced a waterfall in the Chedrang, and obstructed the Krishnai so as to form a lake several miles in extent, flooding a village and killing a forest of not less than 50,000 *sal* trees. At a certain point in the Himalayan foothills, the steep slopes have been stripped bare by landslides from crest to base, the valley bottoms being piled up with débris and broken trees, producing a scene of indescribable desolation. At this point the landslides usually left a sharp and bare ridge-line, but the crest of one ridge retained a narrow strip of its old forest, although the trees were all broken down by the violent oscillations that they suffered. Many streams, that once consisted of a succession of deep pools and rocky rapids, have been so charged with sand from landslides that their valleys are aggraded and they now flow in broad, shallow, sandy channels. A narrative account of the earthquake has been published by H. Luttman-Johnson (*Jour. Soc. Arts.* xlvi, 1898, 473–493).

W. M. Davis.

BOTANICAL NOTES.

TREES OF THE NORTHERN PLAINS.

A recent preliminary list of the seed-bearing plants of North Dakota, by Professor Bolley and L. R. Waldron, throws some light on the woody vegetation of the northern portion of the Great Plains. An examination of this interesting list confirms the supposition hitherto entertained that the species of trees are fewer in number as we go north from the central region, there being but twenty-eight, or possibly twenty-nine, different species in the region covered by it. A closer study of the list shows that of these twenty-nine species of trees less than twenty attain to such dimensions as to make them important timber trees, viz.: basswood, sugar maple (a doubtful native species), red maple (more probably silver maple), box elder, red ash, green ash, white elm, red elm, hackberry, western red birch, ironwood, bur oak, black willow, almond willow, American aspen, large-toothed aspen, balsam poplar, cottonwood and red cedar. The other trees are wild red plum, Canada plum, wild red cherry, choke cherry, buffalo berry, two hawthorns, speckled alder, low bur oak and sandbar willow. Of the timber trees, constituting the first list, box elder, red ash, green ash, white elm, hackberry, cottonwood and probably black willow and almond willow occur throughout the State; basswood, both maples, red elm, ironwood, both aspens and balsam poplar are found only in the eastern counties; bur oak in the eastern half of the State; western red birch in the Turtle Mountains (along the Canadian border), and red cedar in the foothills of the southwestern portion of the State. The absence of locusts, sycamores, hickories, walnuts, white oaks, red oaks and pines is a notable feature of the arborescent vegetation of this portion of the plains.

SHRUBS OF THE NORTHERN PLAINS.

The preliminary list referred to above shows that there are in North Dakota forty-four species of shrubs, a small number when compared with areas of approximately equal extent elsewhere in the United States or Canada. Thus in Nebraska, which is but very little greater in area, there are eighty-six species of shrubby plants.

In examining the list of North Dakota shrubs one is struck by the fact that but five are distinctly western, viz.: skunk bush (*Rhus trilobata*), Western sand cherry (*Prunus besseyi*), Western wild cherry (*Prunus demissa*), Western Juneberry (*Amelanchier alnifolia*), and the silver berry (*Elaeagnus argentea*). These western species may be supposed to have moved from the western mountains out upon the plains, or to have originated here. All the other shrubs are more or less common eastern species which may be assumed to have pushed out from the body of eastern vegetation as has been observed elsewhere on the plains. Among these familiar eastern shrubs are prickly ash, bittersweet, wild grage (*Vitis vulpina* L.), Virginia creeper, smooth sumach, sweet sumach, poison ivy, red raspberry, wild roses (four species), wild gooseberries (four species), cornels (three species), wild honeysuckles (three species), hazels (two species), willows (three species), and junipers (two species). The meadow sweet (*Spiraea salicifolia*), and choke berry, common shrubs of the Eastern States, appear to have entered these northern plains from Minnesota, the Canada buffalo berry from the northeast, and the shrubby cinquefoil from the Rocky Mountains.

NEW EDITION OF THE PHYTOGEOGRAPHY OF NEBRASKA.

THE greater portion of the first edition of the 'Phytogeography of Nebraska,' by Pond and Clements, having been destroyed in the fire which occurred in the publisher's establishment, the Regents of the University of Nebraska authorized a new edition, which has now appeared as a volume of the publications of the Botanical Survey. As the edition is small the distribution of copies is necessarily limited. One hundred copies only have been placed on sale, and when these are sold the edition will be exhausted. The disbursing agent is the University Publishing Company, Lincoln, Nebr. A review of this new edition will appear in a future number of SCIENCE.

BOTANY AND AGRICULTURE.

THE 'Proceedings of the Twenty-first Annual Meeting of the Society for the Promotion of Agricultural Science,' just at hand, is a neatly-printed pamphlet of nearly two hundred pages. An examination of its contents shows that botany as one of several sciences (chemistry, zoology, entomology, meteorology, physics), having relation to agriculture, occupied an unusually large place in the discussions in the New York meeting last June. There were twenty-four papers presented, and exactly one half of these were botanical. Four of the papers had a distinctly horticultural bearing, two were in the domain of plant pathology, two dealt with the chemical aspects of certain plant problems, one discussed weeds, one was in the field of agricultural engineering, and two were devoted to botanical pedagogics. These papers all appear to be more than ordinarily valuable, but those which interest us most are Dr. Trelease's discussion of 'The Botanic Garden as an Aid to Agriculture,' and Mr. Galloway's 'Twenty Years' Progress in Plant Pathology.' It is not within our province to make note of the non-botanical papers, among which are a number of promising titles. The volume is well worth the perusal of every scientific man who is interested in the applications of science to the problems in agriculture.

FIELD ECOLOGY IN THE ROCKY MOUNTAINS.

THE Department of Botany, of the University of Nebraska, offers a course in Field Ecology, to be given in the Rocky Mountains about Pike's Peak during the coming summer. The headquarters of the party will be at Minnehaha, at an altitude of 8,300 feet, from which the plains, foothill, sub-alpine and alpine regions are easily accessible. The work will be under the charge of Dr. Frederic E. Clements, and will begin the first of July and close the first of September. It will consist of a study of the floristics of the various regions, as an introduction to the investigation of the plant formations with respect to their structure and distribution. The special object of the course, however, will be to interpret individual and vegetational adaptations in the light of a thorough examination of the physical factors present, and to determine by experiment in the field the efficient factors in alpine vegetation. A microscopical laboratory with the usual accessories will be fitted up at Spruce Ridge Cottage. There are no fees in connection with the course,

except a registration fee of two dollars for those desiring university credit. The probable expense for the two months, excluding railway fare, will be about fifty dollars.

Charles E. Bessey.
The University of Nebraska.

THE NATIONAL BUREAU OF STANDARDS.

The bill establishing a National Bureau of Standards which, as we have already noted, was passed by Congress at the end of the session is as follows:

Be it enacted, etc., That the Office of Standard Weights and Measures shall hereafter be known as the National Bureau of Standards.

Section 2. That the functions of the bureau shall consist in the custody of the standards; the comparison of the standards used in scientific investigations, engineering, manufacturing, commerce, and educational institutions with the standards adopted or recognized by the government; the construction, when necessary, of standards, their multiples and subdivisions; the testing and calibration of standard-measuring apparatus; the solution of problems which arise in connection with standards; the determination of physical constants and the properties of materials, when such data are of great importance to scientific or manufacturing interests and are not to be obtained of sufficient accuracy elsewhere.

Sec. 3. That the bureau shall exercise its functions for the Government of the United States; for any State or municipal government within the United States; or for any scientific society, educational institution, firm, corporation, or individual within the United States engaged in manufacturing or other pursuits requiring the use of standards or standard measuring instruments. All requests for the services of the bureau shall be made in accordance with the rules and regulations herein established.

Sec. 4. That the officers and employees of the bureau shall consist of a director, at an annual salary of $5,000; 1 physicist, at an annual salary of $3,500; 1 chemist, at an annual salary of $3,500; 2 assistant physicists or chemists, each at an annual salary of $2,200; 1 laboratory assistant, at an annual salary of $1,400; 1 laboratory assistant, at an annual salary of $1,200; 1 secretary, at an annual salary of $2,000; 1 clerk, at an annual salary of $1,200; 1 messenger, at an annual salary of $720; 1 engineer, at an annual salary of $1,500; 1 mechanician, at an annual salary of $1,400; 1 watchman, at an annual salary of $720; and 1 laborer, at an annual salary of $600.

Sec. 5. That the director shall be appointed by the President, by and with the advice and consent of the Senate. He shall have the general supervision of the bureau, its equipment, and the exercise of its functions. He shall make an annual report to the Secretary of the Treasury, including an abstract of the work done during the year and a financial statement. He may issue, when necessary, bulletins for public distribution, containing such information as may be of value to the public or facilitate the bureau in the exercise of its functions.

Sec. 6. That the officers and employees provided for by this Act, except the director, shall be appointed by the Secretary of the Treasury, at such time as the respective services may become necessary.

Sec. 7. That the following sums of money are hereby appropriated: For the payment of salaries provided for by this act, the sum of $27,140, or so much thereof as may be necessary; toward the erection of a suitable laboratory, of fireproof construction, for the use and occupation of said bureau, including all permanent fixtures, such as plumbing, piping, wiring, heating, lighting and ventilation, the entire cost of which shall not exceed the sum of $250,000, $100,000; for equipment of said laboratory, the sum of $10,000; for a site for said laboratory, to be approved by the visiting committee hereinafter provided for and purchased by the Secretary of the Treasury, the sum of $25,000, or so much thereof as may be necessary; for the payment of the general expenses of said bureau, including books and periodicals, furniture, office expenses, stationery and printing, heating and lighting, expenses of the visiting committee, and contingencies of all kinds, the sum of $5,000, or so much thereof as may be necessary, to be expended under the supervision of the Secretary of the Treasury.

Sec. 8. That for all comparisons, calibrations, tests, or investigations, except those performed for the Government of the United States or State governments within the United States, a reasonable fee shall be charged, according to a schedule submitted by the director and approved by the Secretary of the Treasury.

Sec. 9. That the Secretary of the Treasury shall, from time to time, make regulations regarding the payment of fees, the limits of tolerance to be attained in standards submitted for verification, the sealing of standards, the disbursement and receipt of moneys, and such other matters as he may deem necessary for carrying this act into effect.

Sec. 10. That there shall be a visiting committee of five members, to be appointed by the Secretary of the Treasury, to consist of men prominent in the various interests involved, and not in the employ of the Government. This committee shall visit the bureau at least once a year, and report to the Secre-

tary of the Treasury upon the efficiency of its scientific work and the condition of its equipment. The members of this committee shall serve without compensation, but shall be paid the actual expenses incurred in attending its meetings. The period of service of the members of the original committee shall be so arranged that one member shall retire each year, and the appointments thereafter to be for a period of five years. Appointments made to fill vacancies occurring other than in the regular manner are to be made for the remainder of the period in which the vacancy exists.

SCIENTIFIC NOTES AND NEWS.

MR. J. J. H. TEALL, F.R.S., has been appointed director general of the Geological Survey of Great Britain and Ireland, in succession to Sir Archibald Geikie, who retired on February 28th. Sir Archibald has been in the service of the Survey for forty-six years and has reached the age limit.

AT a meeting of the Canadian Mining Institute held at Montreal on March 6th, it was unanimously decided to recommend the appointment of Professor Frank D. Adams, as director of the Geological Survey of Canada in succession to the late Dr. Geo. M. Dawson.

A COMMITTEE has been formed to erect at Heidelberg a monument in memory of three of its great scientific men, Bunsen, Kirchhoff and von Helmholtz.

PROFESSOR J. J. THOMSON, Cavendish professor of physics at Cambridge University, has been elected a member of the Athenæum Club under the provision which empowers the annual election of nine persons of distinguished eminence.

DR. M. I. PUPIN, professor of electro-mechanics, at Columbia University, and Dr. R. Mark Wenley, professor of philosophy at the University of Michigan, will represent their universities at the Ninth Jubilee of the University of Glasgow, which takes place in June.

MR. PERCY WILSON, of the New York Botanical Garden, is accompanying Professor Todd's expedition to the Dutch East Indies to observe the total solar eclipse. He will make collections for the Garden.

MR. JARED G. SMITH, of the U. S. Department of Agriculture, left Washington on March 15th for Honolulu, to assume the directorship of the Agricultural Experiment Station.

THE Division of Forestry of the U. S. Department of Agriculture has selected from its working force two trained lumbermen with some knowledge of forestry to be sent to the Philippine Islands in compliance with a cable request of the Taft Philippine Commission. The persons selected for this work are Mr. Grant Bruce, formerly a State forester in New York, and Mr. Edward Hamilton. Both these men are expert lumbermen with some training in forestry, and have been selected in view of their special fitness for the Philippine work. A bureau of forestry was established in the Philippines in April, 1900, with Capt. George P. Ahern, Ninth United States Infantry, in charge.

AT a meeting of the American Academy of Arts and Sciences on March 13th, the following fellows were elected:

Resident Fellows:

ALEXANDER WILMER DUFF, of Worcester, Physics.

THEODORE LYMAN, of Brookline, Physics.

LEWIS JEROME JOHNSON, of Cambridge, Technology and Engineering.

HENRY LLOYD SMYTH, of Cambridge, Technology and Engineering.

FRANK SHIPLEY COLLINS, of Malden, Botany.

EPHRAIM EMERTON, of Cambridge, Political Economy and History.

FRANK WILLIAM TAUSSIG, of Cambridge, Political Economy and History.

Associate Fellows:

ELIAKIM HASTINGS MOORE, of Chicago, Mathematics and Astronomy.

GEORGE ELLERY HALE, of Williams Bay, Physics.

EDWARD LEAMINGTON NICHOLS, of Ithaca, physics, in place of the late William Augustus Rogers.

CYRUS GUERNSEY PRINGLE, of Charlotte, Vermont, Botany, in place of the late George Clinton Swallow.

FRANKLIN PAINE MALL, of Baltimore, Zoology and Physiology, in place of the late Alfred Stillé.

HENRY FAIRFIELD OSBORN, of New York, Zoology and Physiology, in the place of the late Othniel Charles Marsh.

CHARLES OTIS WHITMAN, of Chicago, Zoology and Physics.

WILLIAM STEWART HALSTED, of Baltimore, Medicine and Surgery, in place of the late William Alexander Hammond.

WILLIAM WILLIAMS KEEN, of Philadelphia, Medicine and Surgery, in the place of the late Jacob Mandes Da Costa.

Foreign Honorary Members:

JULES HENRI POINCARÉ, of Paris, Mathematics and Astronomy, in the place of the late Francesco Brioschi.

HENRICH MÜLLER-BRESLAU, of Berlin, Technology and Engineering.

HUGO KRONECKER, of Bern, Zoology and Physiology, in place of the late Willy Kühne.

ROBERT KOCH, of Berlin, Medicine and Surgery, in place of the late Louis Pasteur.

SIR THOMAS LAUDER BRUNTON, of London, Medicine and Surgery, in place of the late Sir James Paget, Bart.

ALBERT VENN DICEY, of Oxford, Philosophy and Jurisprudence.

WILLIAM EDWARD HEARN, of Melbourne, Philosophy and Jurisprudence, in place of the late Charles Russell, Baron Russell of Killowen.

HENRY JACKSON, of Cambridge, Philosophy and Archæology, in place of the late Henry Sidgwick.

EDMONDO DE AMICIS, of Florence, Literature and the Fine Arts, in place of the late John Ruskin.

PROFESSOR SIMON NEWCOMB gave the fourth address of the series on the Progress and Tendency of Science during the Nineteenth Century before the Washington Academy of Sciences on March 19th, his subject being 'The Progress and Tendency of Astronomy.'

PROFESSOR JACQUES LOEB, of the University of Chicago, read a paper on 'Artificial Parthenogenesis' before the American Philosophical Society at Philadelphia on March 15th.

DR. SIMON FLEXNER, of the University of Pennsylvania, who went to San Francisco to investigate, on behalf of the U. S. Government, the alleged existence of the bubonic plague in that city, lectured before the Academy of Sciences on 'Defense against Disease.'

GEORGE FRANCIS FITZGERALD, since 1881 Erasmus Smith professor of natural and experimental philosophy at Dublin, died on February 21st, at the age of forty-nine years. The Faculty of Science of the newly-constituted University of London has passed the following resolution in his memory:

That this meeting of the Faculty of Science of the University of London, having heard with profound sorrow of the premature death of the late Professor George Francis Fitzgerald, desires to place on record its high appreciation of his brilliant qualities as a man, as a teacher, as an investigator, and as a leader of scientific thought, and to express to his family its mournful sympathy under the calamity which has befallen science and his many friends.

PROFESSOR CHARLES MCDONALD, for more than thirty years professor of mathematics in Dalhousie College, died in Halifax, N. S., on March 10th.

THE death is announced of Mr. R. G. Halliburton, of Canada, known for his political and scientific writings. He was sixty-nine years of age.

MR. ANDREW CARNEGIE, as all our readers are doubtless aware, has offered to give $5,200,000 to New York City for the construction of buildings for sixty-five branch libraries. The city must provide land and maintenance. The offer has been made in conference with Dr. John S. Billings, director of the New York Public Library, and it is understood that the branch libraries would be administered in connection with the public library. The acceptance of Mr. Carnegie's offer would probably require special legislation, but the city officers have expressed themselves strongly in favor of the plan. Mr. Carnegie has also offered to give $1,000,000 for a library at St. Louis. Mr. Carnegie's gifts and offers awaiting acceptance amount to over $20,000,000, largely for library buildings.

THE American Museum of Natural History has recently received a gift of $1,500 from Mr. John L. Cadwalader, of New York, for the purpose of mounting groups of birds illustrating seasonal changes of plumage and other adaptive features of bird life. The fund is to be expended under the direction of Mr. Frank M. Chapman, associate curator.

MR. HUGH LEONARD has given £100 and Sir William J. Farrer £50 to the Royal Institution of London for experimental research at low temperatures.

MR. FORDHAM MORRIS, of New York City, has presented to the American Museum of Natural History a painting representing Audubon with his gun, dog and horses made by his sons, John and Victor, in the late forties a few years before his death. The painting is

now on exhibition in the library reading-room.

THE University College of South Wales and Monmouthshire has received £800 towards the £1,000 required for the Museum of Anatomy proposed as a memorial to Professor A. W. Hughes.

AT a recent meeting of the Canadian Mining Institute a committee was appointed to urge upon the Government an increase of the salaries of those engaged in the Geological Survey, and the need of providing a suitable building at Ottawa for the geological collections.

THE Peary Arctic Club has reelected President Morris K. Jesup, Treasurer Henry W. Cannon and Secretary Herbert L. Bridgman. It likely that a steamer, the fifth, will be chartered and dispatched to find the *Windward*, from which, since the departure from Godhaven, North Greenland, August 20, 1900, with Mrs. Peary and Miss Peary, nothing has been heard.

LIEUTENANT R. F. SCOTT, R.N., the leader of the British Antarctic Expedition, has made to a representative of Reuter's Agency a statement in the course of which he says that the preparations for the British Antarctic Expedition are now practically complete. The *Discovery*, the expedition's ship, will be launched on the 23rd inst., and, after she has been handed over by the contractors, will come round to London, where her equipment and provisions will be put aboard. The *Discovery* has been built on whaler lines, only with greatly increased strength to withstand ice pressure. She is 171 ft. long and 34½ ft. beam, and has 1,500 tons displacement. She will have auxiliary steam, and is fitted with engines of the latest type. In her construction the lines of the *Fram*, though carefully studied, have not been adopted, as Nansen's ship would have been ill-adapted for the heavy seas the *Discovery* will have to encounter. The expedition will leave London in July or August, and will proceed to Melbourne, reaching there in November. The actual work of the expedition will then begin. The naval staff, in addition to Lieutenant Scott, consists of Lieutenant A. R. Armitage (second in command), Lieutenant Charles Royds, and two other officers yet to be appointed. The civilian staff will consist of Professor Gregory, of Melbourne University (director of the civilian scientific staff), Mr. Hodgson (biologist), and Mr. Shackleton (physicist). The medical staff will consist of Dr. Koettlitz and Mr. Wilson.

THE department committee appointed by the British Board of Agriculture to inquire into the conditions under which agricultural seeds are at present sold has completed its report. The committee has come to the conclusion that the seed trade in England is on the whole well conducted and has of late years improved with the advance of science. Nevertheless the majority of the committee recommends that one central station should be provided in the United Kingdom for the purpose of testing the purity and germinating power of seeds sent to it for official examination.

THE British Museum (Natural History) has purchased for £350, an elephant's tusk, which is said to be the largest ever known. The following are its weight and dimensions: Weight, 226½ lbs. Length—outside curve, 10 ft. 2½ in.; inside curve, 9 ft.; base to point in straight line, 8 ft. 2 in. Circumference—at hollow end, 24 in.; at solid 24½ in. Diameter—at hollow end, 8½ in.; at solid, 7⅞ in.

THE following bill was recommended for passage by the committee on coinage, weights and measures, Mr. Southern, chairman, in the closing days of the last Congress.

A Bill, To adopt the weights and measures of the metric system as the standard weights and measures in the United States.

Be it enacted by the Senate and House of Representatives of the United States of America in Congress Assembled: That on and after the first day of January, nineteen hundred and three, all the Departments of the Government of the United States, in the transaction of all business requiring the use of weight and measurement, except in completing the survey of public lands, shall employ and use only the weights and measures of the metric system; and on and after the first day of January, nineteen hundred and three, the weights and measures of the metric system shall be the legal standard weights and measures of and in the United States.

GOVERNOR ODELL, of New York, has signed

the bill abolishing the Forest, Fish and Game Commission and the Forestry Preserve Board as now constituted—consolidating their departments and placing them under the charge of a State Forest, Fish and Game Commissioner.

THE following bill regulating the practice of medicine has been favorably reported in the New York Assembly by the Committee on Public Health :

Any person shall be regarded as practicing medicine who shall for remuneration, charge, fee, gift, bonus or reward, directly or indirectly profess to heal, or who shall give treatment to any other person by the use of any means or method whatever, whether with or without the use of any medicine, drug, instrument, or other appliance, for the relief or cure of any wound, fracture, or bodily injury, infirmity, physical or mental, or other defects or diseases.

This article is not to apply to any person giving treatment to another under the direction or upon the prescription of a physician, duly licensed by the laws of this State. Neither is it to prohibit the manufacture, sale, or use of patent medicines where no diagnosis is made by the maker or seller ; or of the giving temporary relief in an emergency by a registered pharmacist or any person, or the domestic administration of family remedies ; or any person in charge of or employed in any gymnasium from giving suggestions or advice as to form or methods of exercise, or any optician engaged in adapting glasses to the sight, or any rights of chiropodists under existing laws, or the manufacture or construction of optical instruments.

THE subjects of the Walker prizes in Natural History awarded by the Boston Society of Natural History are as follows: For 1901 : 'Monograph on any problem connected with, or any group belonging to, the North American fauna or flora'; for 1902: (1) 'Nuclear fusions in plants'; (2) 'The fate of specific areas of the germ of chordates, as determined by local destruction'; (3) 'The reactions of organisms to solutions, considered from the standpoint of the chemical theory of dissociation.' Further particulars may be obtained from Mr. C. L. Batchelder, secretary of the Society.

PROFESSOR WILLIAM TRELEASE, director of the Missouri Botanical Garden, has sent out an announcement calling attention to the opportunities offered by the Garden for original research. It calls attention to the fact that in establishing and endowing the Garden, its founder, Henry Shaw, desired not only to afford the general public pleasure and information concerning decorative plants and their best use, and to provide for beginners the means of obtaining good training in botany and horticulture, but also to provide facilities for advanced research in botany and cognate sciences. Persons who wish to make use of these are invited to correspond with the director, outlining with as much detail as possible the work they desire to do at the Garden, and giving timely notice so that provision may be made for the study of special subjects.

DR. B. E. FERNOW, director of the New York State College of Forestry, announces that the spring courses for the junior and senior year students in the College Forest, at Axton, will begin on April 16th and continue until June 13th. In addition to the practical forestry work in silviculture, forest mensuration, surveying, exploitation and forest regulation under the direction of Professers Roth and Gifford, the practical instruction in timber estimating, given last year by Mr. Cyrus P. Whitney, will be repeated. A course of daily lectures on Fish Culture and Game Preservation, beginning April 29th, and lasting two weeks, with laboratory work and field excursions, will be given by Professor Barton W. Evermann, ichthyologist of the U. S. Fish Commission. This course will be open to visitors, as far as accommodations may be found by them in Axton or in the neighborhood.

WE have received the announcement of the twelfth season of the Biological Laboratory of the Brooklyn Institute of Arts and Sciences at Coldspring Harbor, L. I. The laboratory will be open for regular work from July 1st to August 24th, but investigators may make arrangements for a longer residence. A complete series of courses is offered by the Board of Instruction which is as follows :

Professor C. B. Davenport, Ph.D., The University of Chicago, Director of the Laboratory ; D. S. Johnson, Ph.D., Johns Hopkins University, in charge of Cryptogamic Botany ; Professor Henry S. Pratt, Ph. D., Haverford College, in charge of Comparative Anatomy ; Professor Nelson F. Davis, Sc.M., Bucknell University, in charge of Bacteriology ; Mrs. Ger-

trude C. Davenport, S.B., Past Instructor Kansas University, in charge of Microscopic Methods; Henry A. Kelly, Ph.D., Ethical Culture Schools, New York, in charge of Nature Study; Lawrence E. Griffin, Ph.D., Western Reserve University, in charge of Embryology; H. N. Whitford, S.B., The University of Chicago, in charge of Phanerogamic Botany; A. G. Mayer, Ph.D., Brooklyn Institute of Arts and Sciences, Lecturer in Entomology; Professor Stephen R. Williams, Ph.D., Miami University, Instructor in Zoology; Professor W. L. Tower, Antioch College, assisting in Microscopic Methods and in Entomology; Louise B. Dunn, Barnard College, assisting in Ecology; A. F. Blakeslee, A.M., Harvard University, assisting in Botany.

THE Summer Laboratory of Biology of Tufts College was established at South Harpswell, Maine, in 1898, and will hold a second session this year. The announcement states that the regular courses of instruction begin on July 8th and continue for six weeks. The laboratory will be established in a small wooden building directly on the shore and will have accommodations for fifteen or twenty students. South Harpswell is situated on the shores of Casco Bay, sixteen miles from Portland. The bay has a rich fauna and flora and is well adapted for a marine laboratory. South Harpswell itself is well situated, as from it one can readily reach the numerous islands of the bay as well as the outer fishing grounds rich in invertebrates. The laboratory is near the extremity of a narrow peninsula (ten miles in length) and being thus almost entirely surrounded by water is free from mosquitoes while hot weather is unknown. Courses will be given by Professor Kingsley and Dr. Lambert on invertebrate zoology, vertebrate zoology, botany and embryology, and facilities are offered to a certain number of students who are able to carry on their researches without assistance.

APROPOS of the movement for an archeological survey of Michigan and legislation to that effect which is now pending, it is of interest to know that Wisconsin students are about to organize a State archeological association, the objects of which are to encourage to a greater extent than is now possible the study and preservation of Wisconsin antiquities and to establish a closer working relationship between collectors and students in different parts of the State.

THE London *Times* states that a further collection of some 400 photographs of objects and customs of antiquarian and historical interest within the British Islands has been made by the National Photographic Record Association and is now at the offices of the Royal Photographic Society, before being deposited in the British Museum. Sir Benjamin Stone's contribution to the present collection is devoted to the county of Warwick. There are two interiors of Trinity Church, Statford-on-Avon, one showing the chancel with its carved oak screen and fine perpendicular windows, and the other a more general view, taken from the extreme west end, in order to give prominence to the unusually placed organ—over the chancel arch. From the same church are illustrations of the fine Elizabethan monument, of the Clopton family, the mayor's pew, and the ancient sanctuary knocker, the seizing of which by a refugee was sufficient to confer upon him the privilege of sanctuary. Outside the church, too, are the shot marks of a military execution. A considerable number of recumbent effigies are taken from the churches of Meriden, Merevale, and Astley. Shakespeare's tomb at Statford-on-Avon is shown when covered with flowers on the occasion of the festival in April last, and various views of the festival procession are also preserved; while the 'Mop' and the roasting of the ox at Stratford are also recorded. Another series illustrates the entire process of haymaking by hand, from the sharpening of the scythe to the stacking—an interesting series of an unusual type, showing a complete industry. Mr. Calcott gives some views of Bristol, St. Peter's Hospital being a particularly fine specimen of carved timber work with the projecting stories supported by animal grotesques. Miss Mary Cotton has contributed some records from the Ardmore, County Waterford, of the Round Tower and ruined cathedral there, and of the ornamental stones known as the Ogham Stones, inscribed only with horizontal lines of various lengths. Of even greater archeological value are Mr. A. R. Hogg's unique photographs from near the Boyne, of the entrance to the Dowth Mound, and the interior of the Tumulus of New Grange, showing the foundation of the stone roof.

Wales is represented by a series of the famous Celtic crosses at Llantwit Major, near Cardiff. A remarkably fine collection of Norman arches, fonts and crosses is sent from Shropshire by Mr. F. R. Armitage. The largest contribution to the collection has been made by Mr. G. Scamell, who has sent over a hundred photographs, principally taken in and around London, of houses once occupied by well known men, houses which are likely to be pulled down soon and, most important, many of the Old Bailey Courts.

UNIVERSITY AND EDUCATIONAL NEWS.

By recent action of the Legislature of North Carolina the annual appropriation to the State University was increased by $12,500; $60,000 was appropriated for the Normal and Industrial School at Greensboro, N. C.; and $40,000 for the Agricultural and Mechanical College, located at Raleigh, N. C., for payment of debts and buildings.

Henry Stafford Little, of Trenton, has offered $100,000 to Princeton University for the erection of a new dormitory, adjacent to Stafford Little Hall, of which he was the donor.

Harvard University has received $5,000 by the will of the late Jacob Wendell for a scholarship 'to be awarded to a student of excellent standing, exclusive of financial needs.'

Work has been commenced on the new physical laboratory to be erected by the University of Pennsylvania at a cost of $300,000.

The Registrar has just issued the lists of candidates for degrees in Sibley College and other departments of Cornell University. The former numbers about 130; of whom over thirty are in M.E. in electrical engineering, and the remainder mainly in the regular course for M.E., including those in marine and in railway engineering. There will be about twenty candidates for the master's degree, M.M.E. The latter, like M.E., includes marine and railway as well as electrical engineers. The registration of Sibley College is now between 650 and 700, including students engaged in graduate-work and candidates for he second degree. Contracts have just been awarded for the erection of the west central 'dome' of Sibley College, to connect the existing two wings, making a front of about 400 feet, facing the campus from the north. It is to be completed early in the next academic year. It is another step toward the completion of the plans of the founder, by his son, Mr. Hiram W. Sibley. The new building will include new space for the museums and collections and a fine auditorium. This, with accessory extensions of old structures, will add about 20,000 square feet of floor-space to the College buildings. The plans, as prepared for the founder before his death, include further additions of about 40,000 square feet, to give accommodations to a thousand students in mechanical engineering and its subdivisions.

President Patton brought forward some suggestions of much importance at a meeting of the trustees of Princeton University on March 15th, and these were referred to a special committee. They include: (1) Additions to the faculty that will enable the University to offer courses in human anatomy and physiology and in common law, so that students may take in their senior year the equivalent of the first year in professional schools of medicine and law; (2) making it possible for students doing additional work to secure the bachelor's degree in three years; (3) offering additional lectures in the sophomore year.

It appears that the disturbances in the Russian universities are continuing, it being reported that 700 students have been arrested at Moscow.

At Yale University the following instructors have been promoted to assistant professorships: E. W. Scripture in psychology; A. W. Evans in botany, and H. E. Gregory in physical geography.

At Princeton University, Dr. W. M. Rankin has been promoted to a full professorship of invertebrate morphology, and Dr. C. F. W. McClure to a full professorship of comparative anatomy.

Dr. Peter Guthrie Tait, since 1860 professor of natural philosophy at Edinburgh University, has resigned his chair on account of ill health.